HUMAN AND COMPUTER INTERACTION

BY

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UNIT-I

HCI What? HCI Why?

- What happens when a human and a computer system interact to perform a task?
  - task - write document, calculate budget, solve equation, learn about Bosnia, drive home, make a reservation, land a plane...

- Why is this important?

1. Computer systems affect every person
2. Safety, satisfaction, utility is critical
3. Product success depends on ease of use

Interfaces in the Real World

- Not just computers!
  - VCR
  - Wristwatch
  - Phone
  - Copier
  - Car
  - Plane cockpit
  - Airline reservation
  - Air traffic control
  - Running shoes!

Goals of HCI

- Allow users to carry out tasks
  - Safely
  - Effectively
  - Efficiently
  - Enjoyably

Usability

- Crucial issue in this area!

- Combination of
  - Ease of learning
  - High speed of user task performance
  - Low user error rate
  - Subjective user satisfaction
  - User retention over time

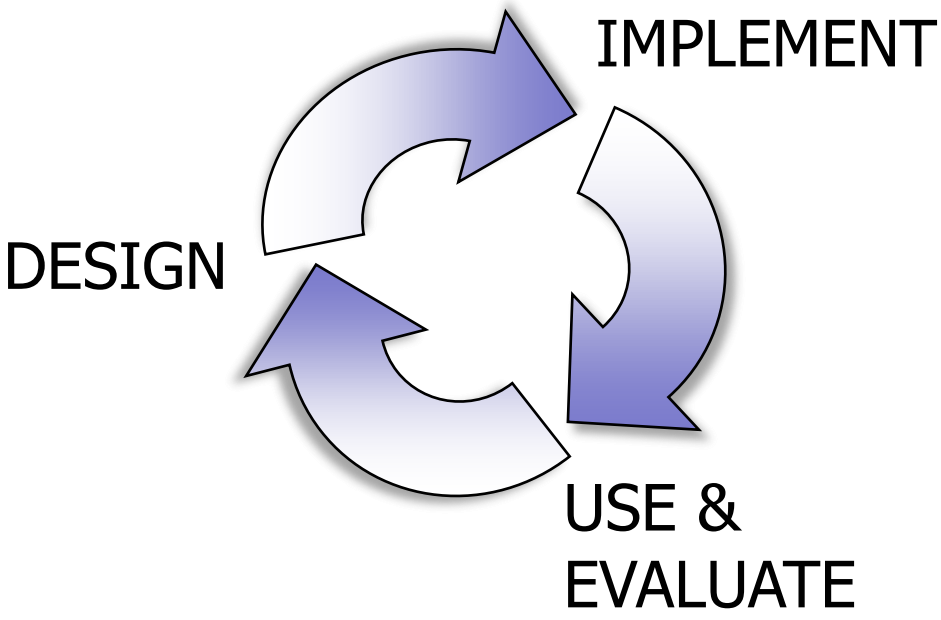
HCI How?

- How do we improve interfaces?

1. Educate software professionals
2. Draw upon fast accumulating body of knowledge regarding H-C interface design
3. Integrate UI design methods & techniques into standard software development methodologies now in place

UI Design/Develop Process

- Tao of User-Centered Design
  - Analyze user's goals & tasks
  - Create design alternatives
  - Evaluate options
  - Implement prototype
  - Test
  - Refine



Above All Else…

- Know the User!
  - Physical & cognitive abilities (& special needs)
  - Personality & culture
  - Knowledge & skills
  - Motivation

- Two Fatal Mistakes:

1. Assume all users are alike
2. Assume all users are like the designer

Design Evaluation

- “Looks good to me” isn’t good enough!
- Both subjective and objective metrics
- Some things we can measure
  - Time to learn
  - Speed of performance
  - Rate of errors by user
  - Retention over time
  - Subjective satisfaction

Course Overview

- Human abilities
- Evaluate an existing system

  (without involving users)
- Design for success
- Dialog & interaction styles
- Evaluate your design (with users)
- Special topics
  - CSCW, InfoVis, Ubicomp, Agents, Audio

Upcoming

- History & Frameworks of HCI
- Project info
- Futuristic scenarios
- Design of Everyday Things (DOET)

- Start reading...
  - DFAB *(note order of chapters)*
  - DOET

UNIT-II

Human Computer Interaction

Interaction and Interaction Design Basics

The Context of the Interaction

- users work within a wider social and organizational context.
- may influence the activity and motivation of the user.
- user may lose motivation if a system that does not match the actual requirements of the job to be done.
- new technology may prove to be a motivation to users if it is designed well

Paradigms for Interaction

- Why study paradigms?
- Obective of an interactive system:- allow the user to achieve particular goals in some application domain (must be usable).
- The designer of an interactive system is posed with two open questions:
  1. How can an interactive system be developed to ensure its usability?
  2. How can the usability of an interactive system be demonstrated or measured?

Paradigms for Interaction Con..

- answering these questions is by means of successful interactive systems to enhance usability by using *paradigms*
- Paradigms for interaction is new computing technologies, creating a new perception of the human-computer relationship.

Paradigms for Interaction Con..

Example Paradigm Shifts

- Batch processing
- Timesharing- single computer supporting multiple users
- Video Display Units- computers for visualizing and manipulating data
- Programming toolkits- provides building blocks to producing complex interactive systems
- Personal computing- small, powerful machines dedicated to the individual
- Window systems and the WIMP interface- humans can pursue more than one task at a time using windows, icons, menus and pointers.

Paradigms for Interaction Con..

- Computer Supported Cooperative Work (CSCW)- CSCW removes bias of single user / single computer system, Electronic mail is most prominent success
- Multimodality- a mode is a human communication channel. It emphasis on simultaneous use of multiple channels for input and output.
- Networking, Graphical display, Microprocessor, WWW and Ubiquitous Computing etc…

Interaction Design Basics

Interaction design: *creating interventions in complex situations using technologies* including PC software, the web and physical devices

- What is design?
- User focus
- Scenarios
- Navigation design
- Screen design and layout
- Interaction and prototyping

What is design?

- **Design involves:**
  - achieving goals within constraints and trade-off between these
  - understanding the raw materials: computer and human
  - accepting limitations of humans and of design.
- **Goals:**

  What is the purpose of the design we are intending to produce?

  Who is it for?

  Why do they want it?

Example: Designing a wireless personal movie player

- **Constraints**

  What materials must we use?

  What standards must we adopt?

  How much can it cost?

  How much time do we have to develop it?

  Are there health and safety issues?

Example: personal movie player

Must we use existing video standards to download movies?

Do we need to build in copyright protection?

What is design? Con…

- **Trade-off** Choosing which goals or constraints can be relaxed so that others can be met.

  Example, An eye-mounted video display
- The *golden rule of design*: **understand your materials**
  - understand *computers*:
    - limitations, capacities, tools, platforms
  - understand *people*
    - psychological, social aspects, human error.

User focus

- The start of any interaction design exercise must be the intended user or users.

  know your users

- **Who are they?-**Are they young or old, experienced computer users
- **Probably *not* like you!-**easy to design as if *you* were the main user
- **Talk to them-**structured interviews about their job or life, open-ended discussions, *participatory design*
- **Watch them-**watch what people do as well as hear what they say
- **Use your imagination-**even if you cannot involve actual users you can at least try to imagine their experiences.

Scenarios

- Scenarios are rich design stories, which can be used and reused throughout design:
  - –they help us see what users will want to do
  - –they give a step-by-step walkthrough of users' interactions: including what they see, do and think.

Navigation design

- Imagine yourself using a word processor or web
- **Widgets and Words in Menu or Button**
  - **Example:-** elements and tags <a href="..."> in the web
- **Screens or windows**
  - **Example:-**page design in the web
- **Navigation within the application**
  - **Example: -**site structure in the web
- **Environment-The word process**
  - **Example:-**the web, browser, external links in the web
- Individual screens or the layout of devices will have their own structure.
  1. Local structure – looking from one screen or page out
  2. Global structure – structure of site, movement between screens.

Screen design and layout

- The different elements that make up interactive applications, consider How we put them together.
- A single screen image often has to present information clearly and also act as the locus for interacting with the system
- ***The basic principles***

  Ask What is the user doing?

  Think What information is required? What comparisons may the user need to make? In what order are things likely to be needed?

  Design Form follows function

Screen design and layout con…

1. ***Grouping and structure***
2. ***Order of groups and items***
3. ***Decoration***
4. ***Alignment***
5. ***White space***

Screen design and layout con…

Grouping and structure

- If things logically belong together, then we should normally physically group them together.
- For example, In a potential design for an ordering screen

Order:

Administrative information

Billing details

Delivery details

Order information

Order line 1

Order line 2

. . .

Screen design and layout con…

Order of groups and items

- filling in the billing details first, followed by the delivery details, followed by the individual order items.
- Is this the right order?

Billing details:	**Delivery details**:
Name	Name
Address: …	Address: …
Credit card no	Delivery time

Order details:

item	quantity	cost/item	cost
size 10 screws (boxes)	7	3.71	25.97
……	…	…	…

Screen design and layout con…

- ***Decoration:*** how the design ***uses boxes and a separating line*** to make the grouping clear. Other decorative features like ***font style, and text or background colors*** can be used to highlight groupings.

- **Allignment**

  Read text from left to right, lists of text items should normally be aligned to the left.

  Numbers, should normally be aligned to the right (for integers) or at the decimal point.

Screen design and layout con…

- ***White space***
- In typography the space between the letters is called the counter.
- In painting and artists -the space between the foreground elements
- the shape of the counter can be used in several ways.
  1. space used to separate blocks in paragraph
  2. Space used to structure areas
  3. space used to highlight quote and graphics

Iteration and Prototyping

- Our first design will not be perfect! - some form of iteration of ideas

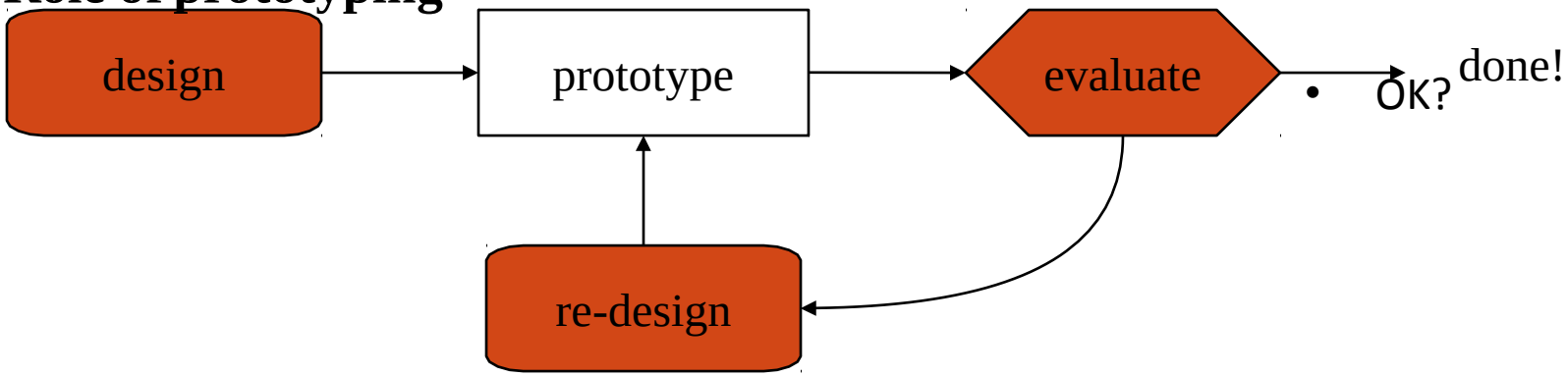
1. paper designs
2. storyboards demonstrated to colleagues and potential users.
3. use mock-up of physical devices or tools

   such as Shockwave or Visual Basic **to create prototype versions of software.**

Iteration and Prototyping con…

- *formative* evaluation-to improve design
- you never get it right first time if at

  first you don't succeed …
- iteration and prototyping are the universally accepted 'best practice' approach for interaction design
- **Role of prototyping**



UNIT-III

- cognitive models

Cognitive models

- goal and task hierarchies
- linguistic
- physical and device
- architectural

Cognitive models

- They model aspects of user:
  - understanding
  - knowledge
  - intentions
  - processing
- Common categorisation:
  - Competence vs. Performance
  - Computational flavour
  - No clear divide

Goal and task hierarchies

- Mental processing as divide-and-conquer
- Example: sales report
  - produce report gather data

. find book names
. . do keywords search of names database
. . . … *further sub-goals*
. . sift through names and abstracts by hand
. . . … *further sub-goals*
. search sales database - further sub-goals
layout tables and histograms - further sub-goals
write description - further sub-goals

goals vs. tasks

- goals – intentions
  what you would like to be true
- tasks – actions
  how to achieve it

- GOMS – goals are internal

- HTA – actions external
  – tasks are abstractions

Issues for goal hierarchies

- Granularity
  - Where do we start?
  - Where do we stop?
- Routine learned behaviour, not problem solving
  - The unit task
- Conflict
  - More than one way to achieve a goal
- Error

Techniques

- Goals, Operators, Methods and Selection (GOMS)
- Cognitive Complexity Theory (CCT)
- Hierarchical Task Analysis (HTA) - Chapter 15

GOMS

Goals

- what the user wants to achieve

Operators

- basic actions user performs

Methods

- decomposition of a goal into subgoals/operators

Selection

- means of choosing between competing methods

GOMS example

```
GOAL: CLOSE-WINDOW
.   [select GOAL: USE-MENU-METHOD
            .   MOVE-MOUSE-TO-FILE-MENU
            .   PULL-DOWN-FILE-MENU
            .   CLICK-OVER-CLOSE-OPTION
            GOAL: USE-CTRL-W-METHOD
            .   PRESS-CONTROL-W-KEYS]

For a particular user:

   Rule 1: Select USE-MENU-METHOD unless another
           rule applies
   Rule 2: If the application is GAME,
           select CTRL-W-METHOD
```

Cognitive Complexity Theory

- Two parallel descriptions:
  - User production rules
  - Device generalised transition networks
- Production rules are of the form:
  - if condition then action
- Transition networks covered under dialogue models

Example: editing with vi

- Production rules are in long-term memory
- Model working memory as attribute-value mapping:

  (GOAL perform unit task)

  (TEXT task is insert space)

  (TEXT task is at 5 23)

  (CURSOR 8 7)

- Rules are pattern-matched to working memory,

  e.g., LOOK-TEXT task is at %LINE %COLUMN is true, with LINE = 5 COLUMN = 23.

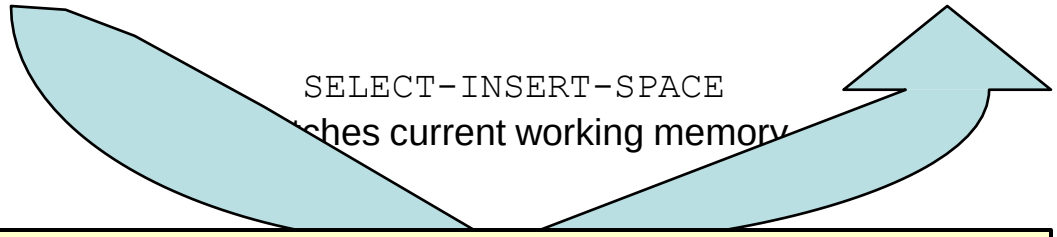
Four rules to model inserting a space

Active rules:

```
SELECT-INSERT-SPACE
INSERT-SPACE-MOVE-FIRST
INSERT-SPACE-DOIT
INSERT-SPACE-DONE
```

New working memory

```
(GOAL insert space)
(NOTE executing insert space)
(LINE 5) (COLUMN 23)
```




```
(SELECT-INSERT-SPACE
IF (AND (TEST-GOAL perform unit task)
        (TEST-TEXT task is insert space)
        (NOT (TEST-GOAL insert space))
        (NOT (TEST-NOTE executing insert space)))
THEN (  (ADD-GOAL insert space)
        (ADD-NOTE executing insert space)
        (LOOK-TEXT task is at %LINE %COLUMN)))
```

Notes on CCT

- Parallel model
- Proceduralisation of actions
- Novice versus expert style rules
- Error behaviour can be represented
- Measures
  - depth of goal structure
  - number of rules
  - comparison with device description

Problems with goal hierarchies

- a post hoc technique
- expert versus novice
- How cognitive are they?

Linguistic notations

- Understanding the user's behaviour and cognitive difficulty based on analysis of language between user and system.
- Similar in emphasis to dialogue models

- Backus–Naur Form (BNF)
- Task–Action Grammar (TAG)

Backus-Naur Form (BNF)

- Very common notation from computer science
- A purely syntactic view of the dialogue
- Terminals
  - lowest level of user behaviour
  - e.g. CLICK-MOUSE, MOVE-MOUSE
- Nonterminals
  - ordering of terminals
  - higher level of abstraction
  - e.g. select-menu, position-mouse

Example of BNF

- Basic syntax:
  - nonterminal ::= expression
- An expression
  - contains terminals and nonterminals
  - combined in sequence (+) or as alternatives (|)

```
draw line      ::=  select line + choose points + last point
select line    ::=  pos mouse + CLICK MOUSE
choose points  ::=  choose one   |   choose one + choose points
choose one     ::=  pos mouse + CLICK MOUSE
last point     ::=  pos mouse + DBL CLICK MOUSE
pos mouse      ::=  NULL  |  MOVE MOUSE+ pos mouse
```

Measurements with BNF

- Number of rules (not so good)
- Number of + and | operators
- Complications
  - same syntax for different semantics
  - no reflection of user's perception
  - minimal consistency checking

Task Action Grammar (TAG)

- Making consistency more explicit
- Encoding user's world knowledge
- Parameterised grammar rules
- Nonterminals are modified to include additional semantic features

Consistency in TAG

- In BNF, three UNIX commands would be described as:

  copy ::= cp + filename + filename | cp + filenames + directory
  move ::= mv + filename + filename | mv + filenames + directory
  link ::= ln + filename + filename | ln + filenames + directory

- No BNF measure could distinguish between this and a less consistent grammar in which

  link ::= ln + filename + filename | ln + directory + filenames

Consistency in TAG (cont'd)

- consistency of argument order made explicit using a parameter, or semantic feature for file operations
- Feature Possible values

  Op = copy; move; link

- Rules

  file-op[Op] ::= command[Op] + filename + filename
  | command[Op] + filenames + directory

  command[Op = copy] ::= cp

  command[Op = move] ::= mv

  command[Op = link] ::= ln

Other uses of TAG

- User’s existing knowledge
- Congruence between features and commands
- These are modelled as derived rules

Physical and device models

- The Keystroke Level Model (KLM)
- Buxton's 3-state model

- Based on empirical knowledge of human motor system
- User's task: acquisition then execution.
  - these only address execution
- Complementary with goal hierarchies

Keystroke Level Model (KLM)

- lowest level of (original) GOMS
- six execution phase operators
  - Physical motor: K - keystroking
P - pointing
H - homing
D - drawing
  - Mental: M - mental preparation
  - System: R - response
- times are empirically determined.

Texecute = TK + TP + TH + TD + TM + TR

KLM example

```
GOAL: ICONISE-WINDOW
[select
   GOAL: USE-CLOSE-METHOD
   .     MOVE-MOUSE-TO- FILE-MENU
   .     PULL-DOWN-FILE-MENU
   .     CLICK-OVER-CLOSE-OPTION
   GOAL: USE-CTRL-W-METHOD
         PRESS-CONTROL-W-KEY]
```

- compare alternatives:
  - USE-CTRL-W-METHOD vs.
  - USE-CLOSE-METHOD
- assume hand starts on mouse

USE-CTRL-W-METHOD		**USE-CLOSE-METHOD**	
H[to kbd]	0.40	P[to menu]	1.1
M	1.35	B[LEFT down]	0.1
K[ctrlW key]	0.28	M	1.35
		P[to option]	1.1
		B[LEFT up]	0.1
Total	**2.03 s**	**Total**	**3.75 s**

Architectural models

- All of these cognitive models make assumptions about the architecture of the human mind.
- Long-term/Short-term memory
- Problem spaces
- Interacting Cognitive Subsystems
- Connectionist
- ACT

Display-based interaction

- Most cognitive models do not deal with user observation and perception
- Some techniques have been extended to handle system output
  (e.g., BNF with sensing terminals, Display-TAG)
  but problems persist
- Exploratory interaction versus planning

UNIT-IV
Integrating Mobile Wallet into Your Ecosystem

PassKit

Passbook

Re-imagine what's in your pocket

Passbook

Enriching customer experiences with PassKit

PassKit

PassKit

GAPP Shop Gift Card

A pass implementation

PassKit

Overview

A. GAPP Shop Gift Card
B. Leveraging Existing Systems
C. Determining Complexity
D. Tips and Tricks

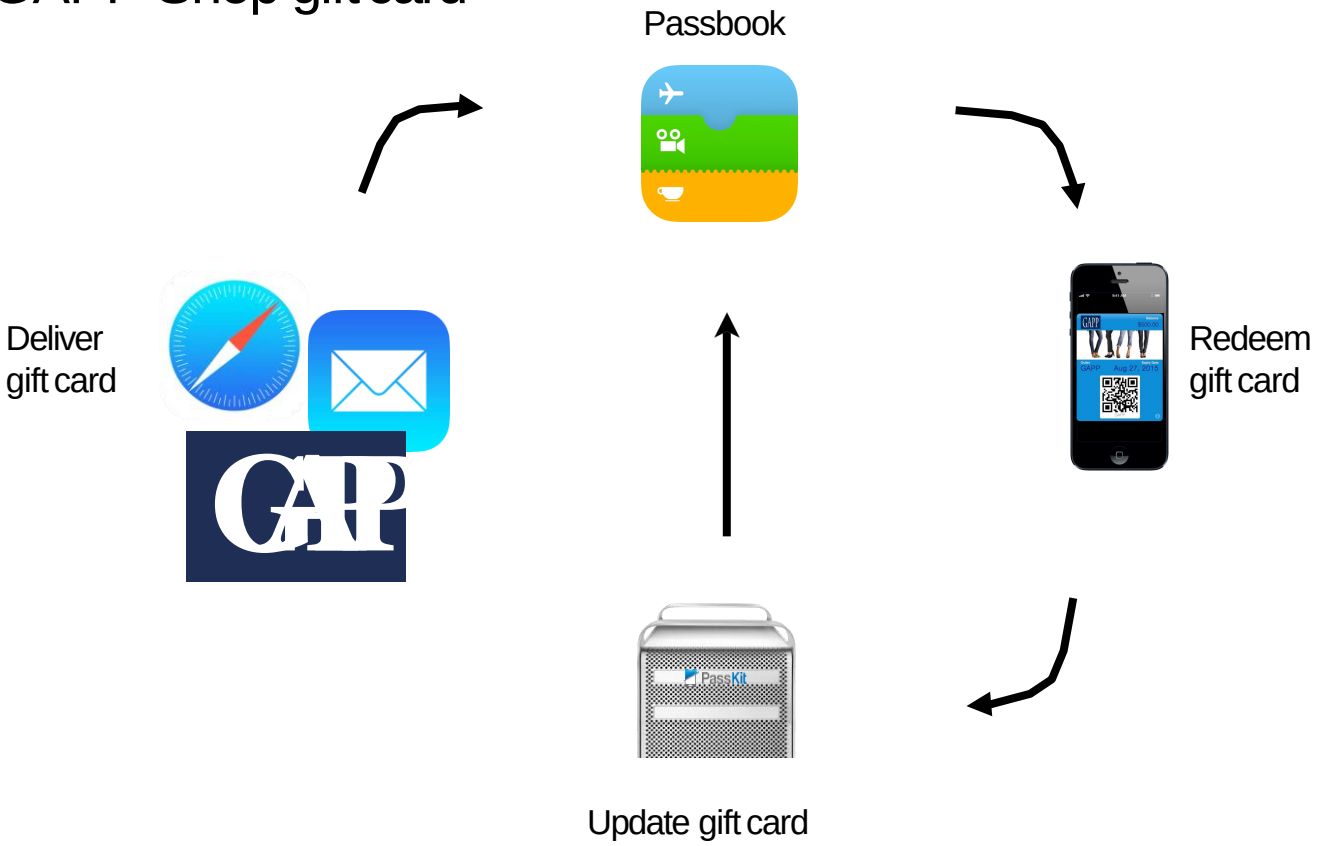
A. GAPP Shop Gift Card

Lifecycle review

PassKit

Lifecycle

GAPP Shop gift card



Deliver the Pass

Getting GAPP shop gift card to the right user

PassKit

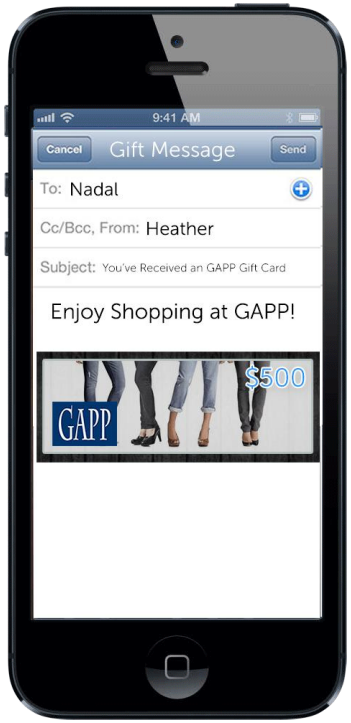
Customer Acquires the Pass

Step One – purchase

PassKit

Customer Acquires the Pass

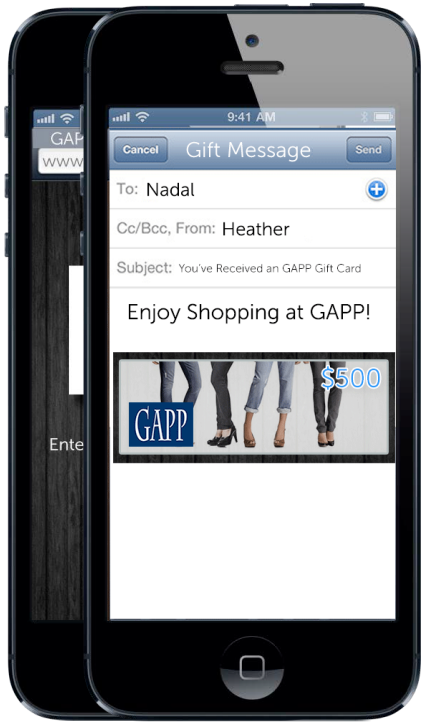
Step Two – populate gift card recipient details

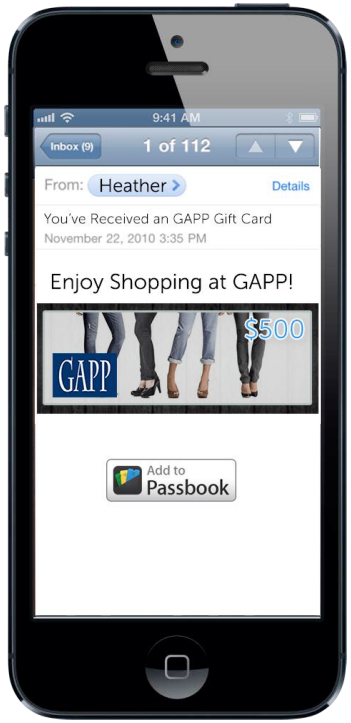


PassKit

Customer Acquires the Pass

Step Three – user receives a gift card





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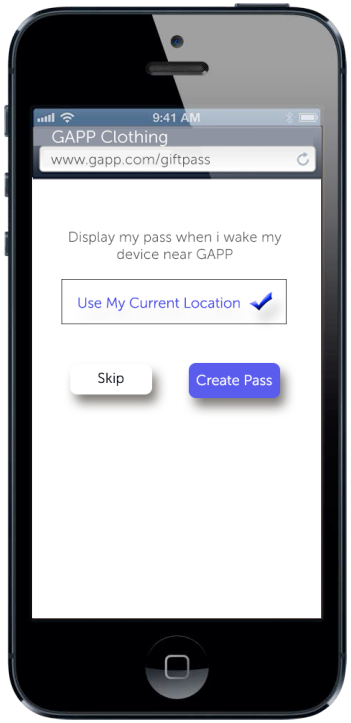
Customer Acquires the Pass

Step Four – user clicks add to Passbook



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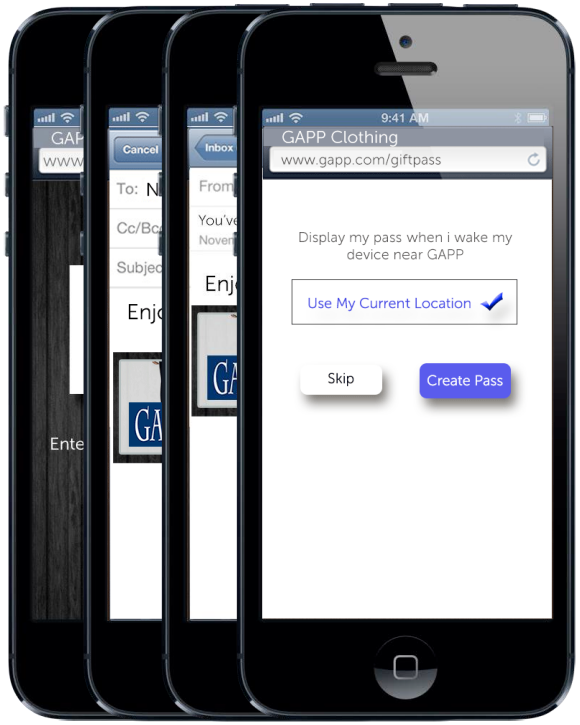
Customer Acquires the Pass

Step Five– user receives store gift card



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Deliver the Pass

GAPP Shop gift card goals

- Passbook should make it easier Existing
- avenues shouldn’t get harder Integrate
- with existing systems

Companion app not required!

Use the Pass

Using GAPP Shop gift card

PassKit

Use the Pass

Purchase in retail GAPP Shop (Offline)

PassKit

Use the Pass

Purchase on the web or on the phone (Online)

PassKit

Use the Pass

GAPP Store gift card goals

- Leverage existing systems
  - Retail Store
    - Point of sale device
    - Optical scanners
  - Web
  - Phone
- Omni channel

PassKit

Human Factor

Retail employees

- Retail employees
- Build a great point of sale user interface
- Which scanner do I use?
  - Laser scanner
  - Optical scanner
  - Handheld 3D scanner
- Any training for employees?

PassKit

Barcodes

No

1-Dimensional

93

GTN-12

EAN-13

Yes

2-Dimensional

PDF-417

Aztec

QR Code

PassKit

Human Factor

Retail employees

- Target user-experience consistency
- Repeatability
- Reproducibility

Update the Pass

Updating GAPP shop gift card

PassKit

Feedback Loop

Keeping your passes alive

- Once a redemption occurs, update the pass
- Feeds back into human factor and customer engagement
- Use PassKit Push Update service

B. Leveraging Your Existing Systems

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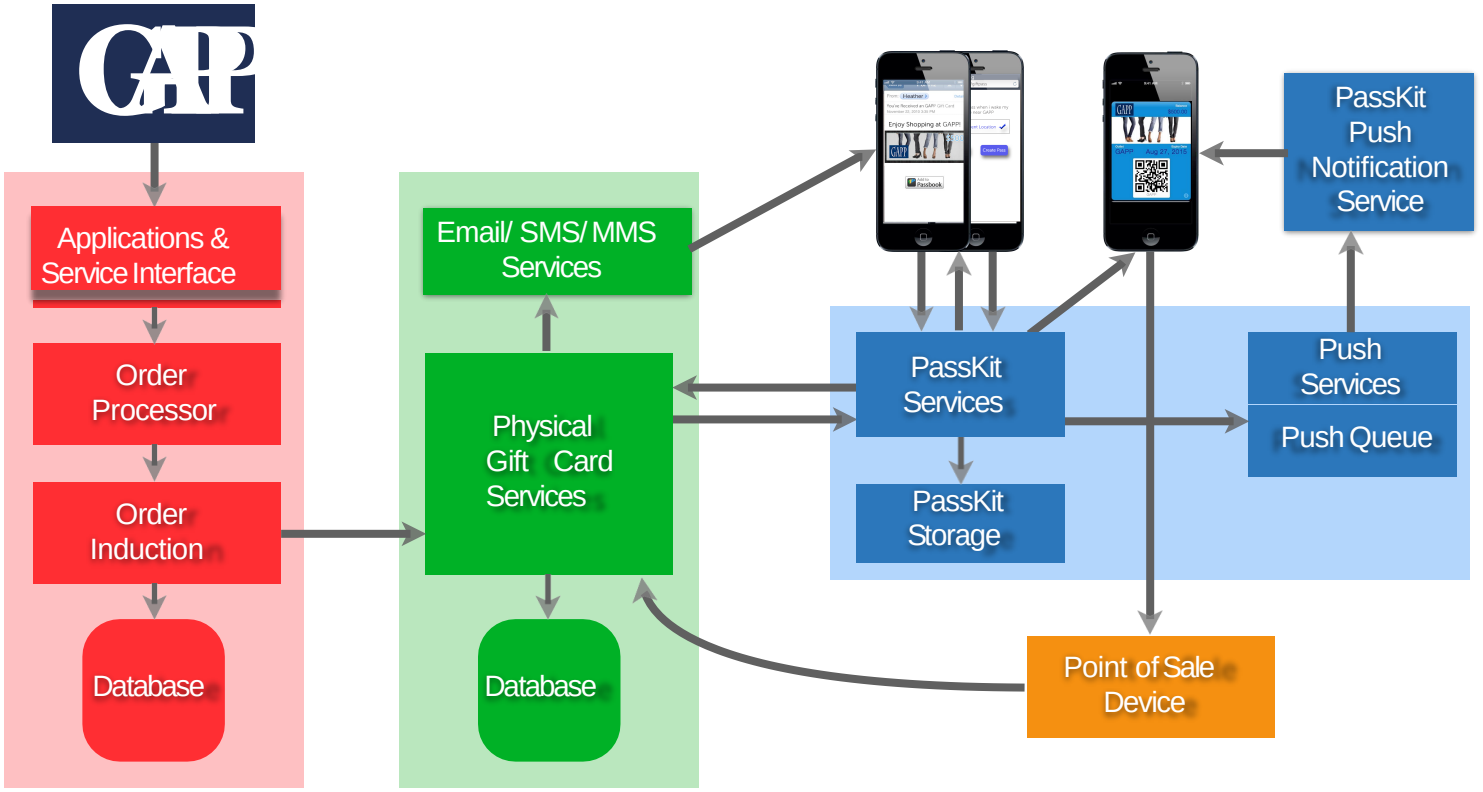
Typical Systems Diagram



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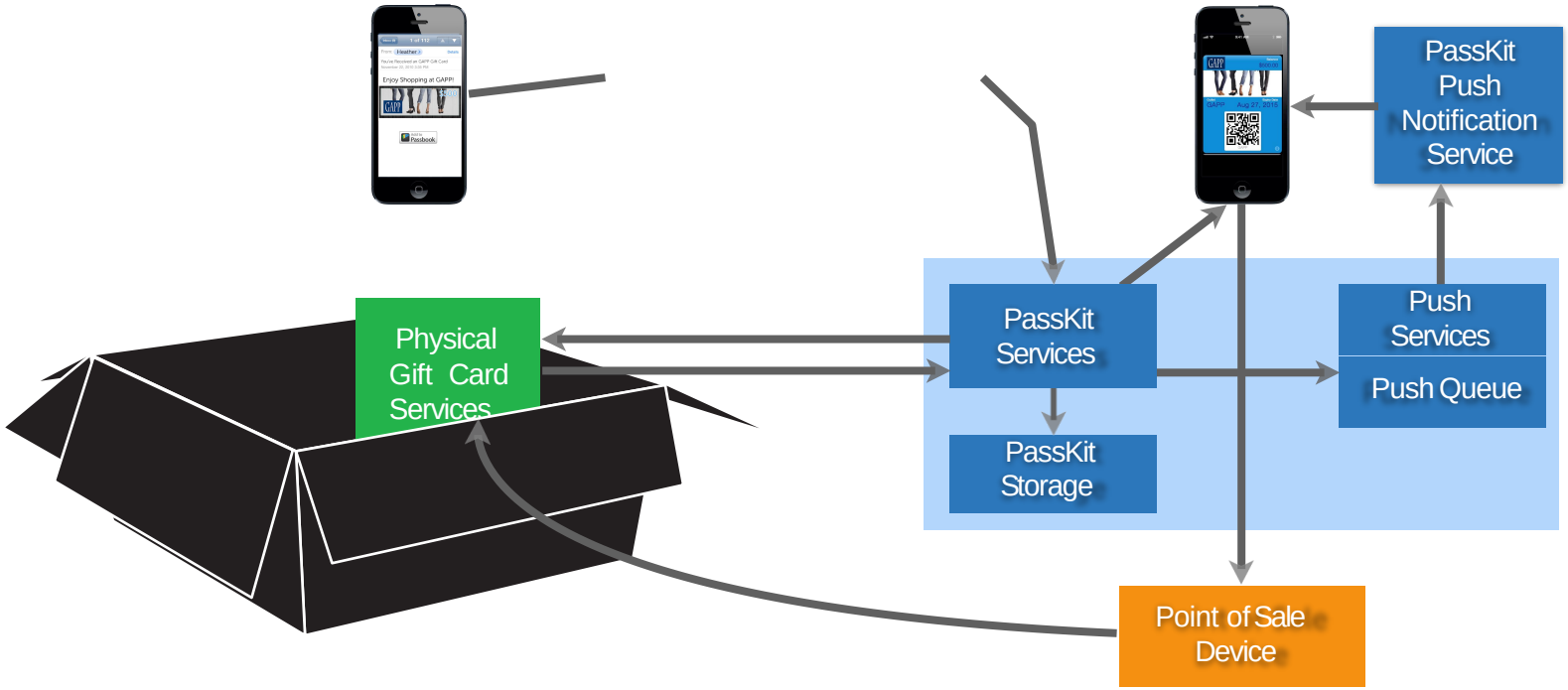
Push to the Black Box

API= Communication link between systems



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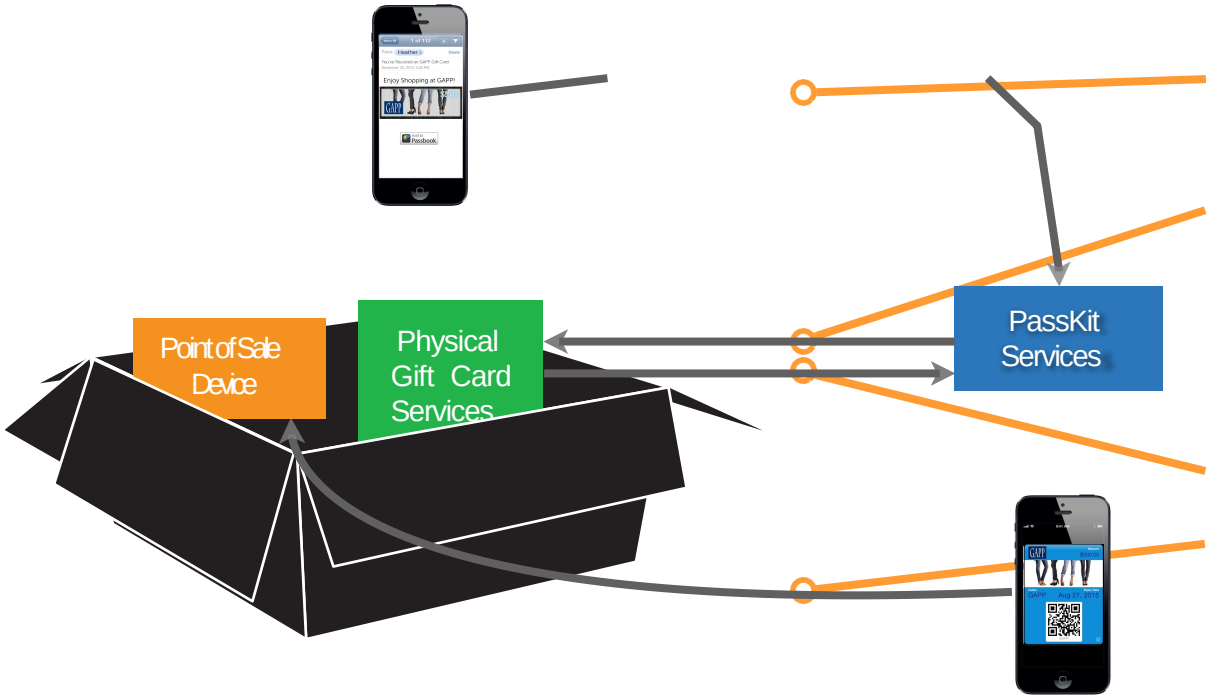
Identify the Minimum Interface

Only maintain the boxes that are relevant



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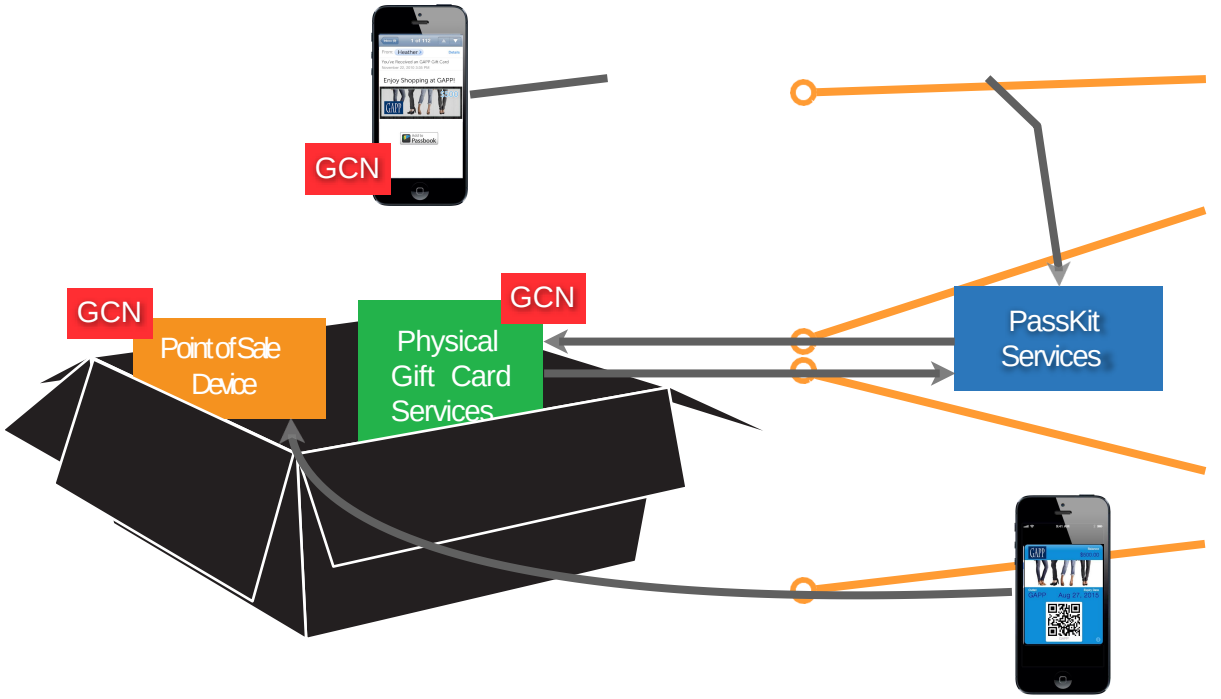
Common Identifier



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Common Identifier

Value known by all interfacing systems

- Gift card number
- Club card number
- Insurance policy number
- Order number
- Event ID
- Event ID with a customer ID

C. Determining Complexity

A way to anticipate the level of effort

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Facets of Complexity

1. Value
2. Uniqueness
3. Static vs. Dynamic
4. Scale
5. System Integration

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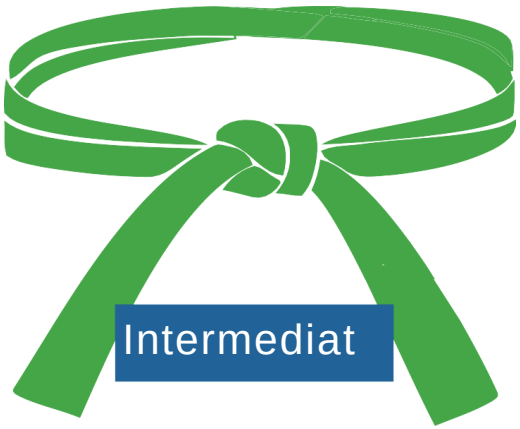
Levels



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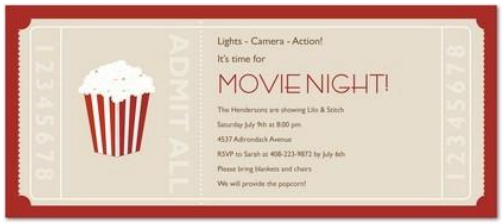
1. Value

Newspaper Coupon

Basic

Movie Ticket



Intermediate

Boarding Pass

Advanced

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2. Uniqueness

Multiple use
Multiple person

Eg: Subway coupon

Multiple use
Single person

Eg: GAPP membership card

Quantified use

Eg: Boarding ticket

3. Static vs. Dynamic

Informational

Eg: Coffee shop coupon

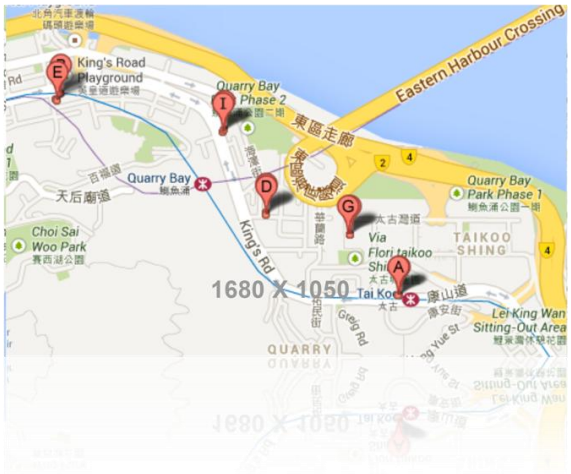
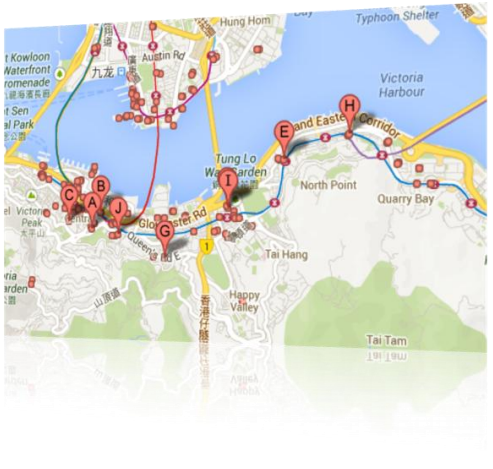
Time sensitive

Eg: Event show time

Multi-state

Eg: Basketball match scoring

4. Scale

Few	More	Many use
		

Eg: Number of locations/Passes/Point of Sales

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5. System Integration

iPhone/ Android

Eg: Smart phone

Basic

Electronic only

Eg: POS System

Intermediate

Tentcards, emails, mobile apps, online/ offline ads

Eg: All channels

Advanced

UNIT-V
Integrating Mobile Wallet into Your Ecosystem

PassKit

Passbook

Re-imagine what's in your pocket

Passbook

Enriching customer experiences with PassKit

PassKit

PassKit

GAPP Shop Gift Card

A pass implementation

PassKit

Overview

A. GAPP Shop Gift Card
B. Leveraging Existing Systems
C. Determining Complexity
D. Tips and Tricks

A. GAPP Shop Gift Card

Lifecycle review

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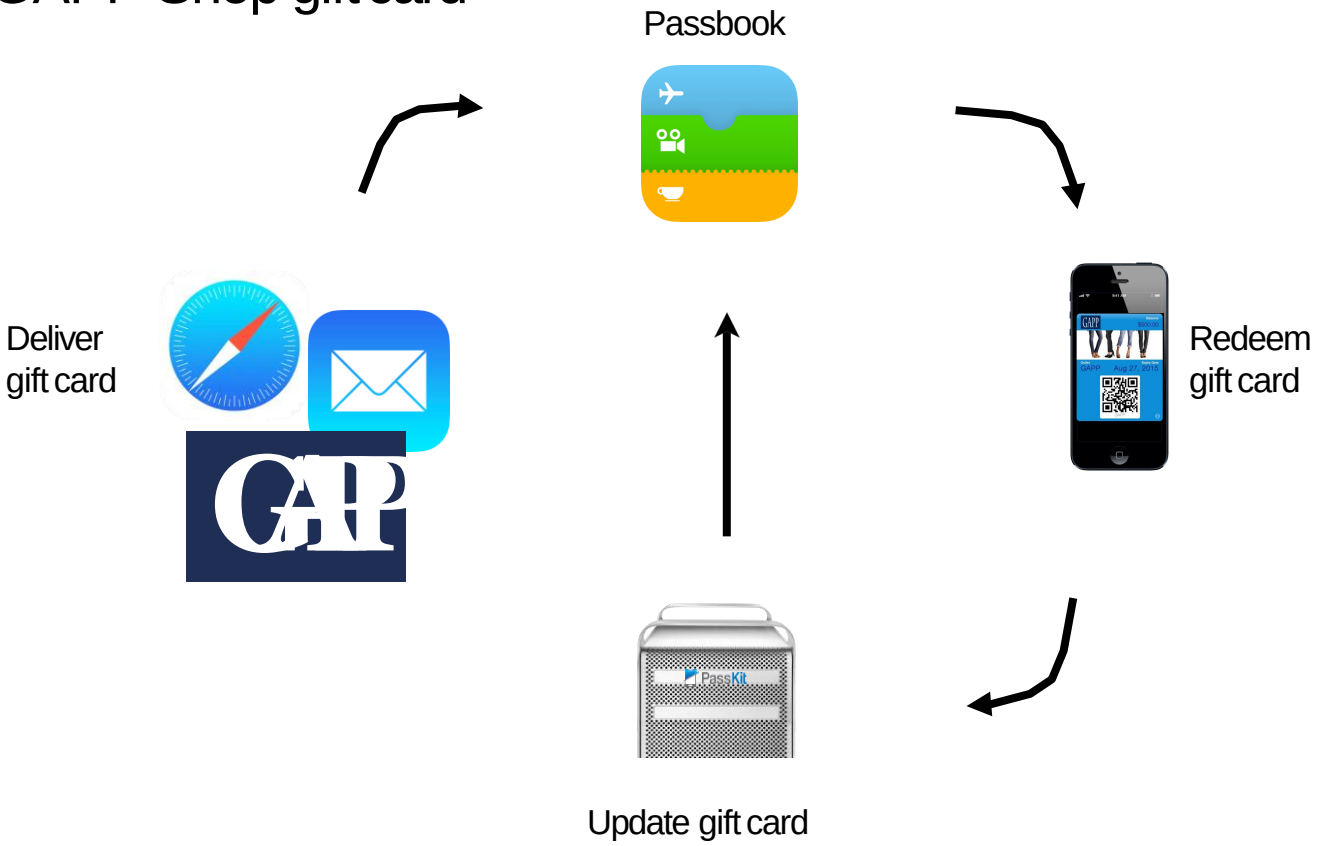
Lifecycle

GAPP Shop gift card



Deliver the Pass

Getting GAPP shop gift card to the right user

PassKit

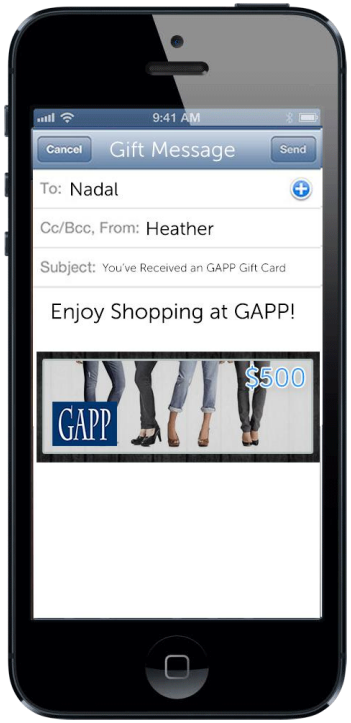
Customer Acquires the Pass

Step One – purchase

PassKit

Customer Acquires the Pass

Step Two – populate gift card recipient details



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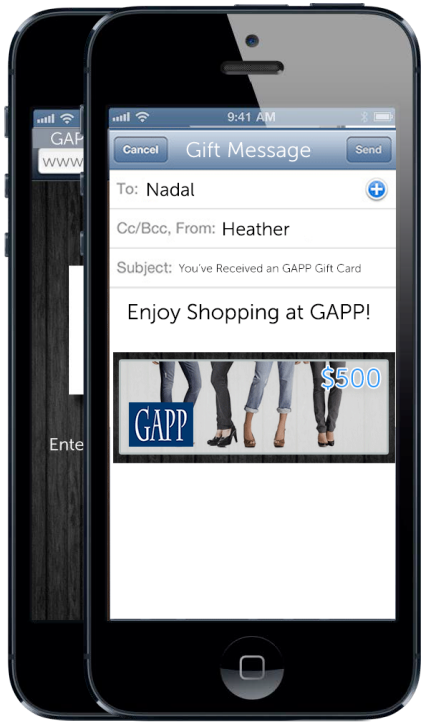
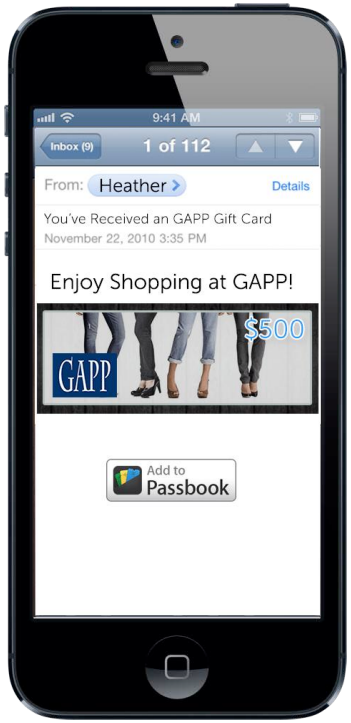
Customer Acquires the Pass

Step Three – user receives a gift card





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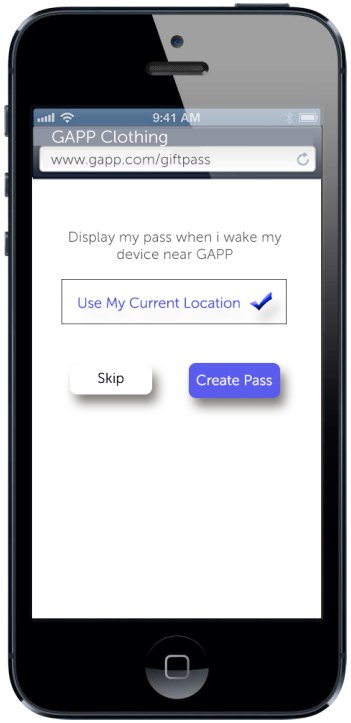
Customer Acquires the Pass

Step Four – user clicks add to Passbook



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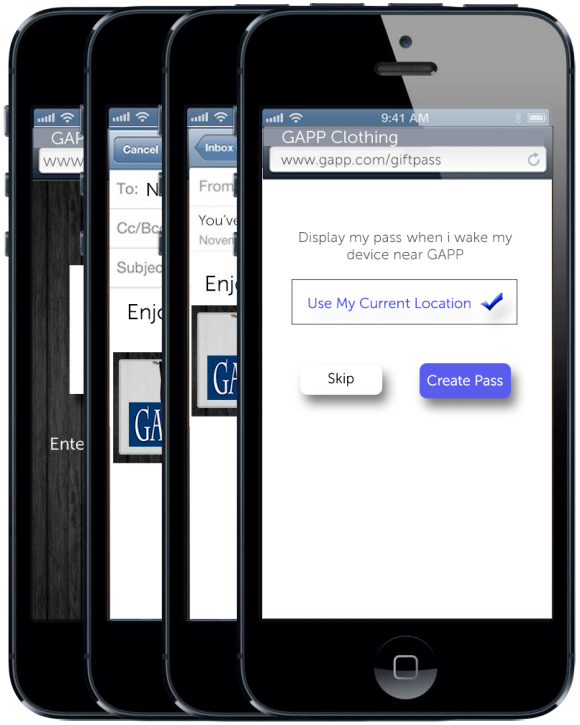
Customer Acquires the Pass

Step Five– user receives store gift card



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Deliver the Pass

GAPP Shop gift card goals

- Passbook should make it easier Existing
- avenues shouldn’t get harder Integrate
- with existing systems

Companion app not required!

Use the Pass

Using GAPP Shop gift card

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Use the Pass

Purchase in retail GAPP Shop (Offline)

PassKit

Use the Pass

Purchase on the web or on the phone (Online)

PassKit

Use the Pass

GAPP Store gift card goals

- Leverage existing systems
  - Retail Store
    - Point of sale device
    - Optical scanners
  - Web
  - Phone
- Omni channel

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Human Factor

Retail employees

- Retail employees
- Build a great point of sale user interface
- Which scanner do I use?
  - Laser scanner
  - Optical scanner
  - Handheld 3D scanner
- Any training for employees?

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Barcodes

No

1-Dimensional

93

GTN-12

EAN-13

Yes

2-Dimensional

PDF-417

Aztec

QR Code

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Human Factor

Retail employees

- Target user-experience consistency
- Repeatability
- Reproducibility

Update the Pass

Updating GAPP shop gift card

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Feedback Loop

Keeping your passes alive

- Once a redemption occurs, update the pass
- Feeds back into human factor and customer engagement
- Use PassKit Push Update service

B. Leveraging Your Existing Systems

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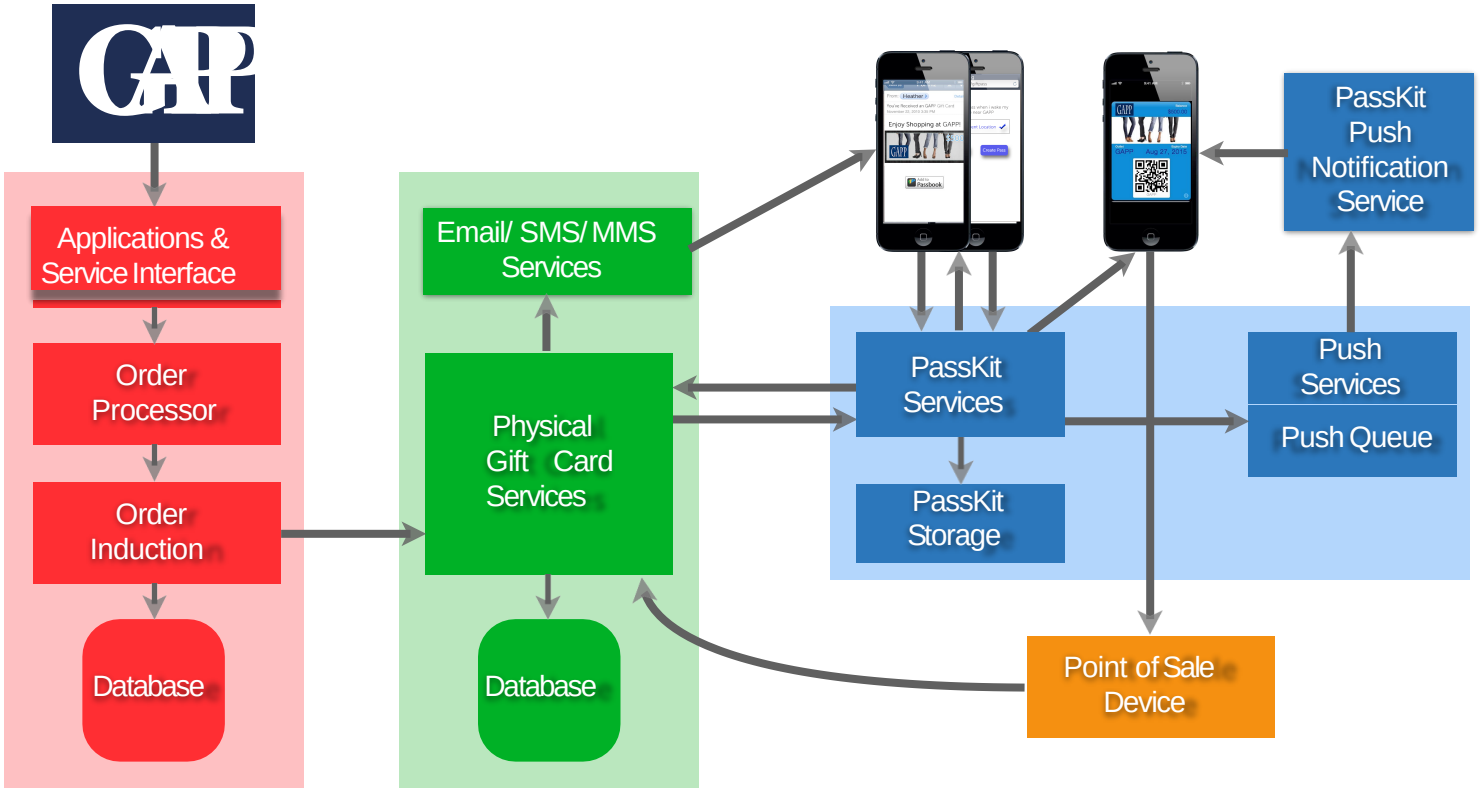
Typical Systems Diagram



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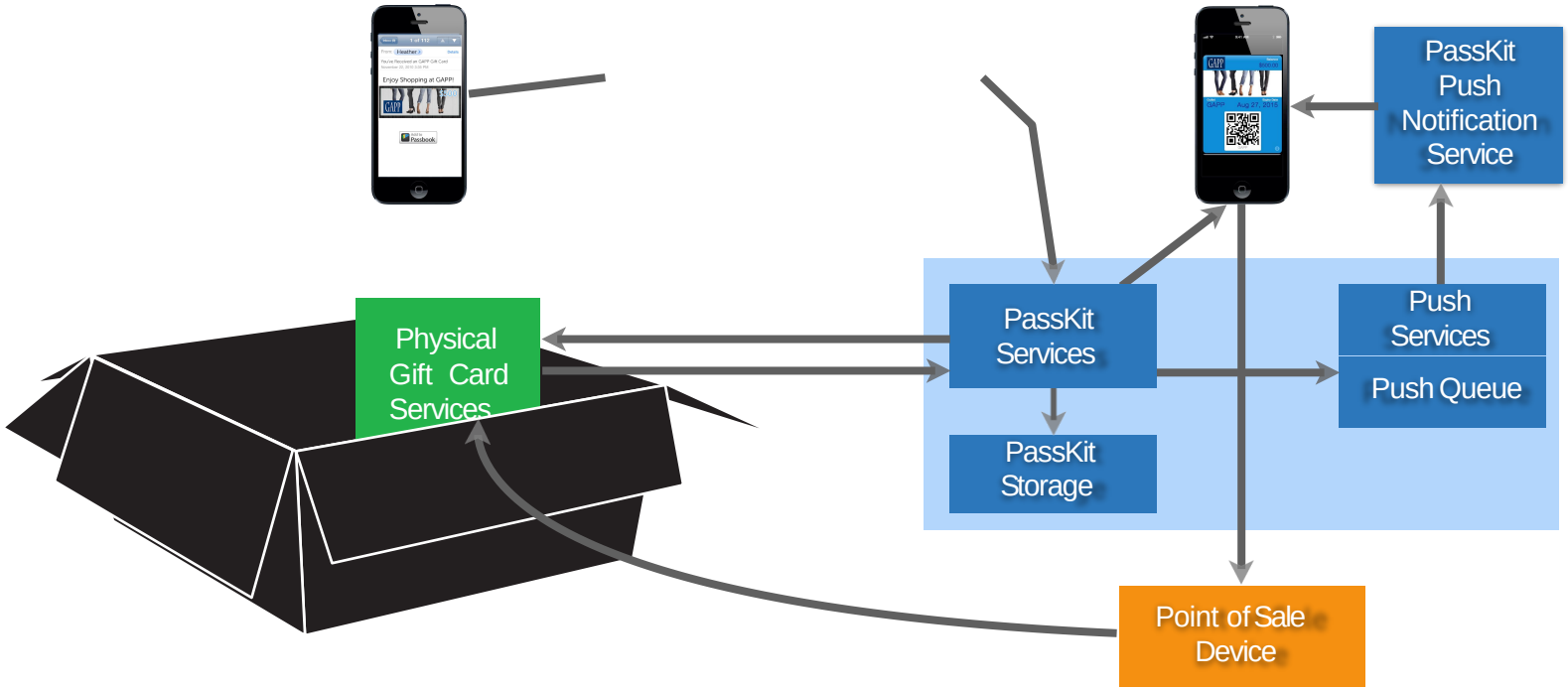
Push to the Black Box

API= Communication link between systems



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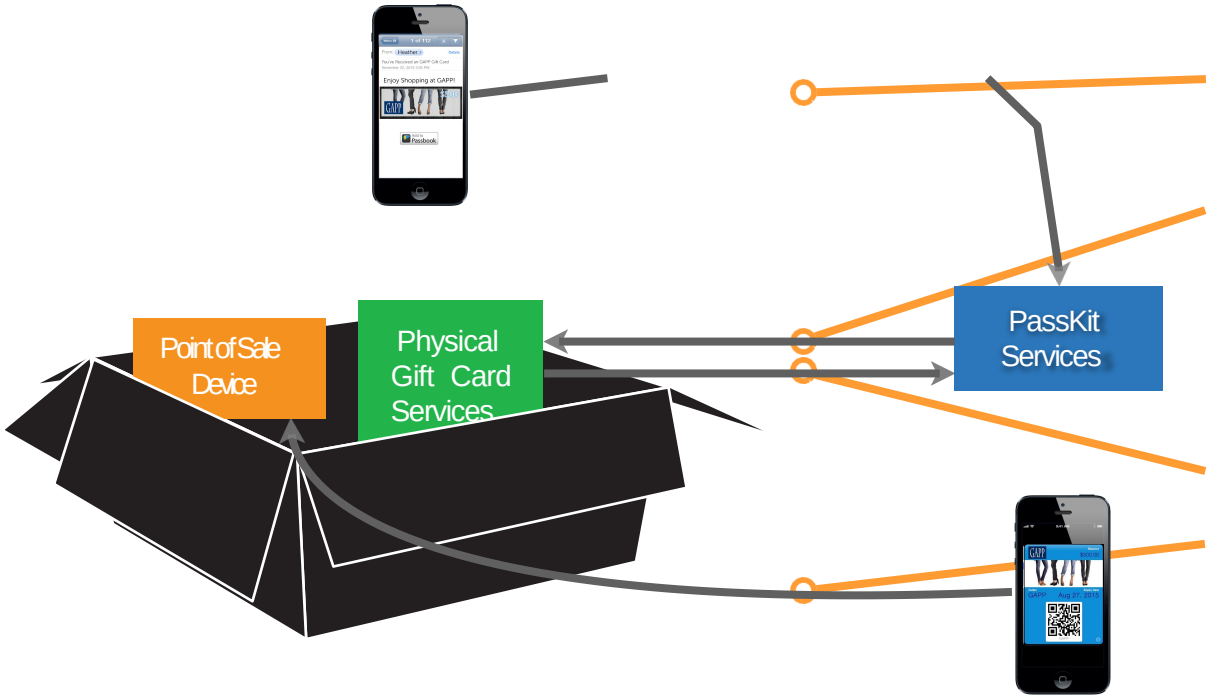
Identify the Minimum Interface

Only maintain the boxes that are relevant



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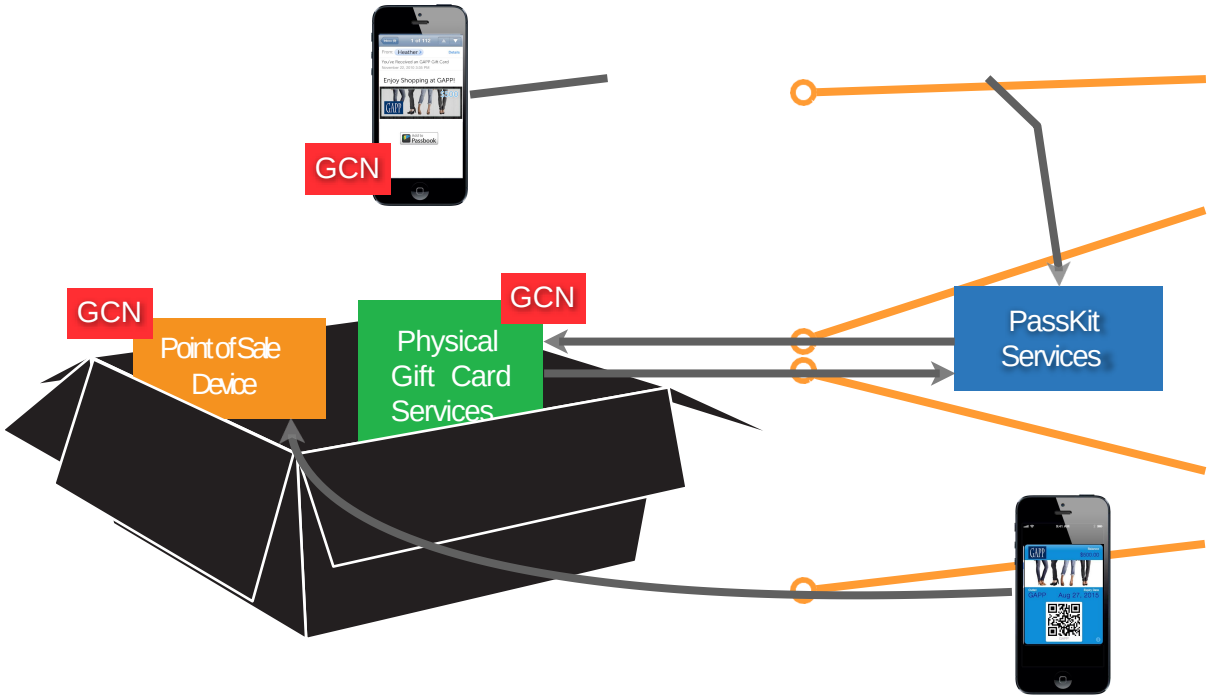
Common Identifier



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Common Identifier

Value known by all interfacing systems

- Gift card number
- Club card number
- Insurance policy number
- Order number
- Event ID
- Event ID with a customer ID

C. Determining Complexity

A way to anticipate the level of effort

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Facets of Complexity

1. Value
2. Uniqueness
3. Static vs. Dynamic
4. Scale
5. System Integration

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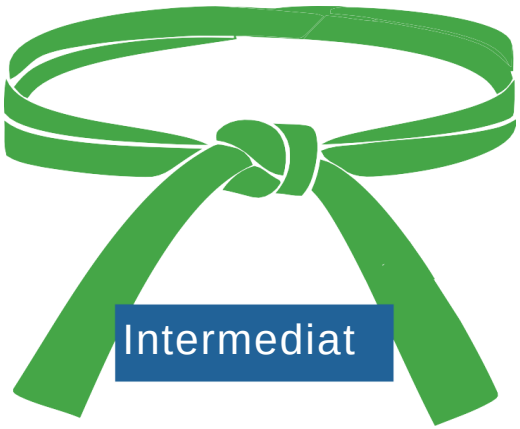
Levels



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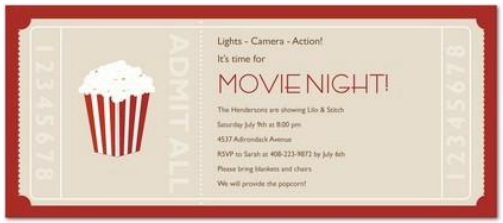
1. Value

Newspaper Coupon

Basic

Movie Ticket



Intermediate

Boarding Pass

Advanced

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2. Uniqueness

Multiple use
Multiple person

Eg: Subway coupon

Multiple use
Single person

Eg: GAPP membership card

Quantified use

Eg: Boarding ticket

3. Static vs. Dynamic

Informational

Eg: Coffee shop coupon

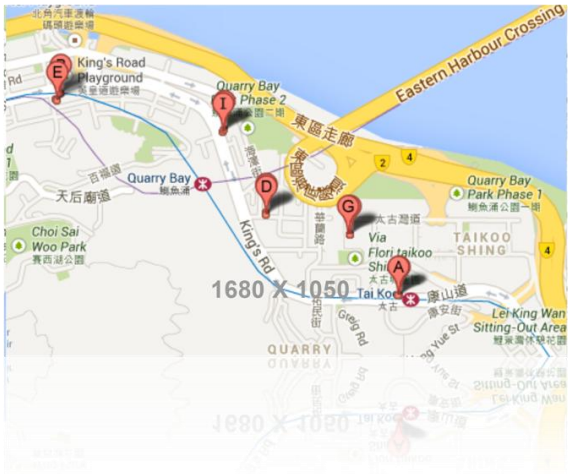
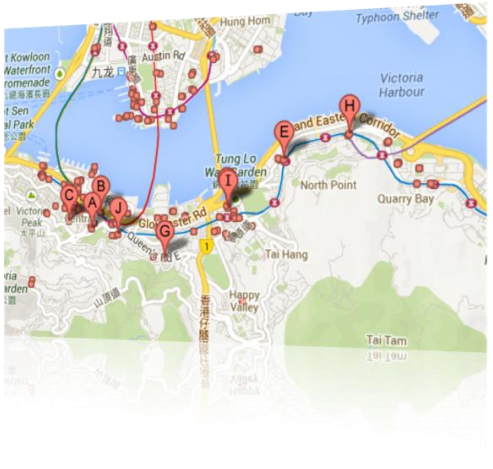
Time sensitive

Eg: Event show time

Multi-state

Eg: Basketball match scoring

4. Scale

Few	More	Many use
		

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Advanced

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Complexity  Better

D. Tips and Tricks

Something for every complexity level

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Tips- Basic

1. Loss on Internet Connectivity
2. Push update services

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1. Loss on Internet Connectivity

Impacts performance, security and reliability

- Issuers
- Users

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2. Push update services

Impacts performance, security and reliability

- Push update services are not 100% reliable

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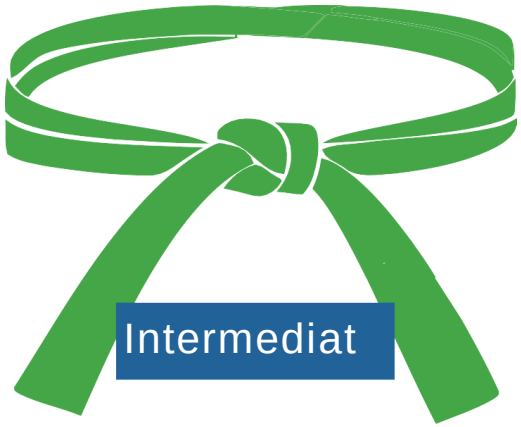
Tips– Intermediate

1. Validate Significant Contents
2. Monitor



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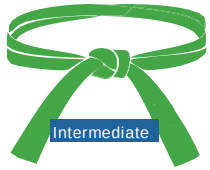
1. Validate Significant Contents



Impacts security

- Anyone can create a pass The
- pass is not authoritative
- Always check the source of truth Eg. is the pass info up-to-date?
- Depends on level of integration

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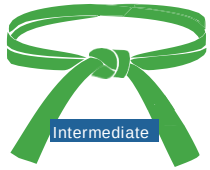
2. Monitor



Impacts reliability

- Be the first to know when your systems go down
- There are numerous external websites that do monitoring
  - Build a query against one of your production testpasses
  - Validate response is right/ wrong
- Internal logging systems
  - Asset sizes
  - Certificate expiration warnings
    (signing and push notification)
- Internal monitoring

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Tips– Advanced

For the most complex passes

1. Distinguish Test and Production Passes
2. Build in Debug-ability

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1. Distinguish Test and Production

Remember the pass type identifier

Pass Type Identifier

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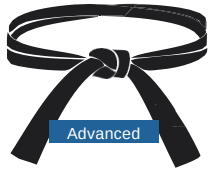
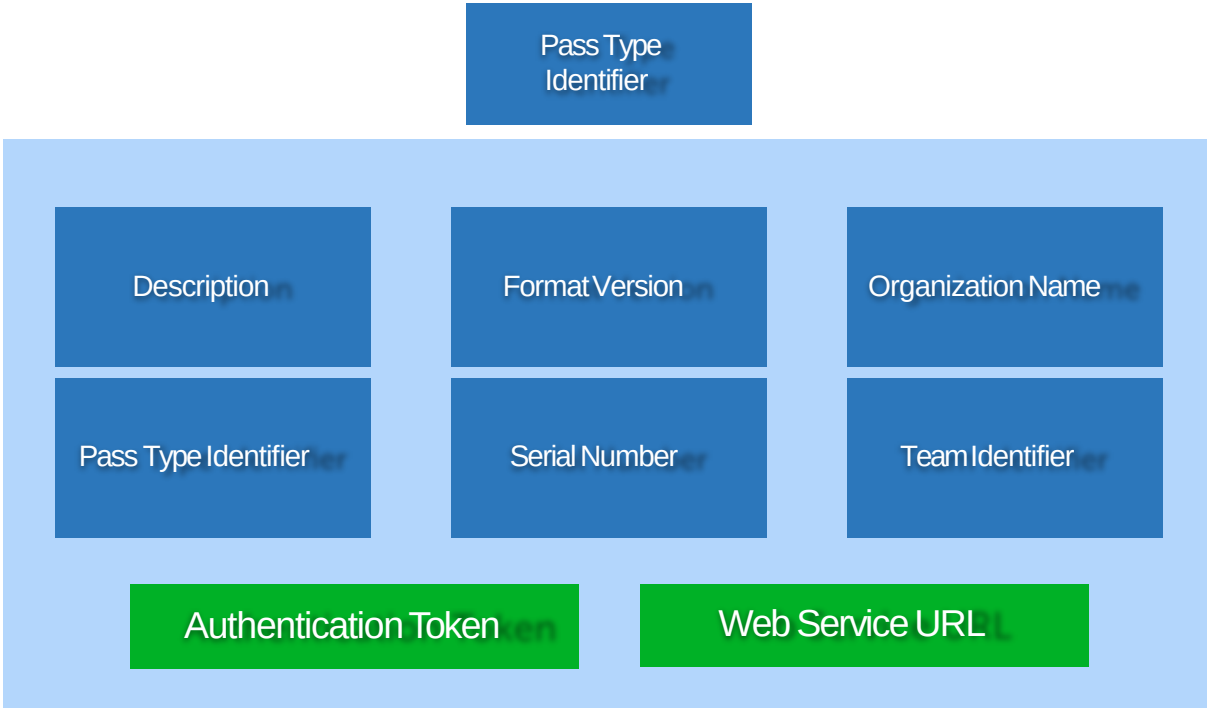
1. Distinguish Test and Production



Passbook package contents



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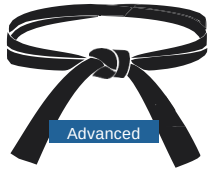
2. Build in Debugging



Impacts reliability

- Be ready to troubleshoot it in production
- Leverage the back of pass for debug information
- Have a test serial number for production
- Turn on a flag on this test pass
- Display extra information on the back of pass
  - Host or datacenter
  - Locations
  - Last updated date

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Summary

A. GAPP Shop Gift Card
B. Leveraging Existing Systems
C. Determining Complexity
D. Tips and Tricks

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PassKit - The Mobile Wallet Cloud Solution

Providing all you need to profit from the mobile wallet