Next-Generation Java Card™ Technology for Secure Mobile Applications

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Goal

What will you gain from this session

Learn about the security requirements of new mobile applications and about the upcoming Java Card technology to support them

About the Speakers

- Eric Vétillard
  - Chairman, Java Card Forum Technical Committee
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- Saqib Ahmad
  - Engineering lead of Java Card platform engineering group at Sun Microsystems, Inc.
- Florian Tournier
  - Group Marketing Manager at Sun Microsystems, Inc.

Agenda

The new wave of mobile applications
- **The smarter mobile environment**
- NFC or the phone as a smart card
- A smart card web server
- **New s**ecurity challenges

Next-Generation Java Card technology

Java™ Technology in a Mobile Environment

- The SIM hosts Java Card platform applications
  - User interface encoded on the card
  - Fairly basic user experience
  - Provides strong security and management services
  - SIM Toolkit APIs enable access to phone resources
- Mobile phones host Java Platform, Micro Edition, (Java ME platform) applicatio
  - Good level of user interface
  - Limited security level
  - Connection to cards using SATSA (Java Specification Request (JSR) 177)

What's New with Handsets ?

- The mobile phone keeps evolving
  - Wider application range
  - Ever improving user experience
  - More external interfaces
  - Enhanced network connectivity

- One small revolution gets overlooked : NFC
  - Standard RFID interface for phones
  - A phone can behave like a card/token, or like a reader
  - The interface is very natural: just swipe your phone

What's New with SIM card[illegible]?

- Moore's law applies to smart cards
  - Very soon: 16K or 32K of RAM
  - 100's KB of EEPROM/Flash, 1MB of ROM
- Price of basic cards has fallen to commodity level
  - Card management is the bulk of the cost
- The security level of SIM cards is increasing
  - The convergence with banking cards has started
- But the model is reaching a limit
  - SIM Toolkit is aging
  - Card protocols (APDU) are a developer bottleneck

Phone/SIM Integration Is Changing

- USB as standard interface
  - USB is widely available on PCs
  - USB has also on selected mobile phones
- TCP/IP as standard protocol
  - Cards and tokens can communicate with the world
- Then, remember: A smart card is a server
  - A Secure and Personal Server
  - A server programming model is next

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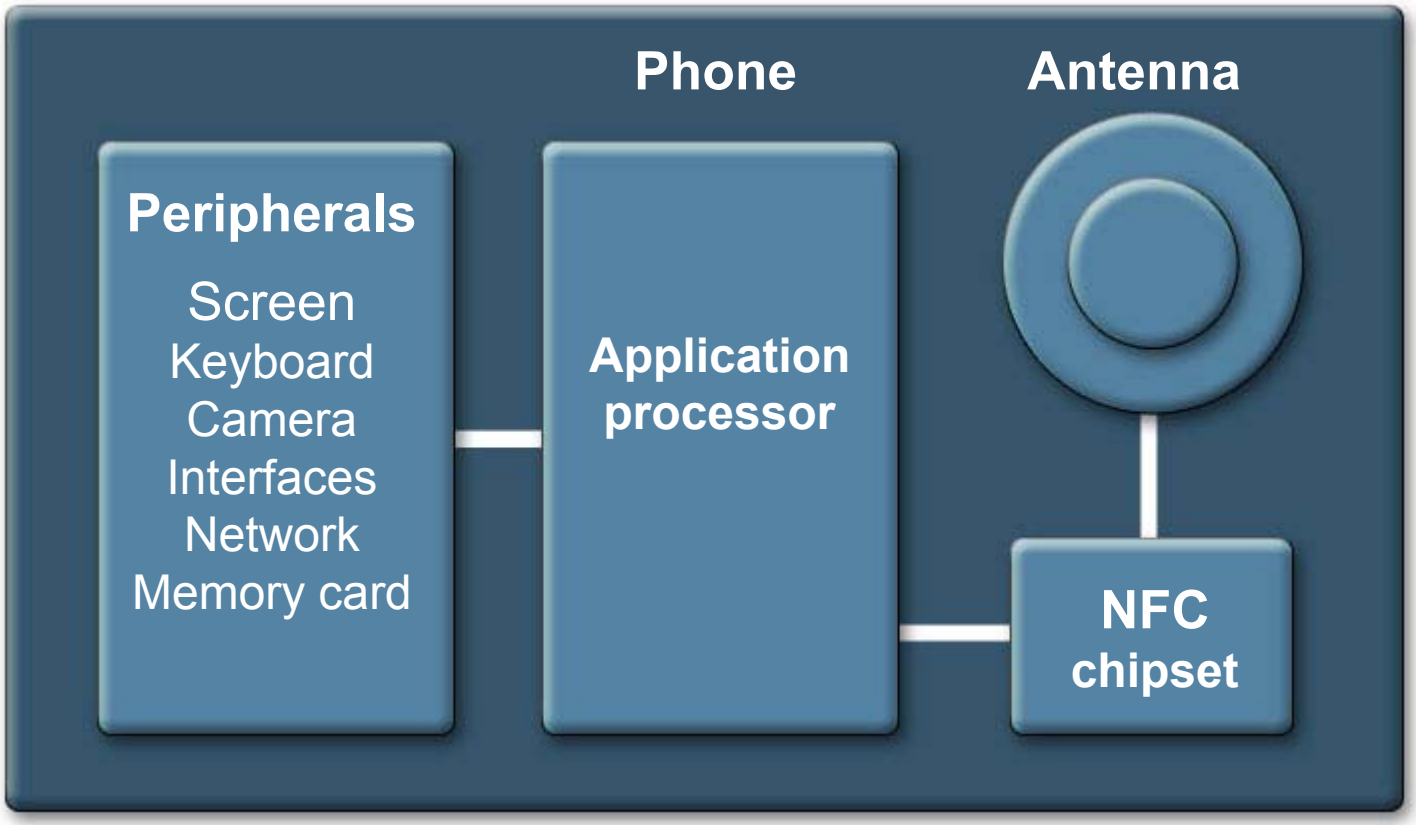
Sensitive Mobile Applications

- NFC brings smart card applications to phones
  - Payment: pay with your phone
  - Transport: enter the subway with your phone
  - Identity: enter your company with your phone
- The phone form factor has advantages over all other form factors
  - A card, or other specific token (key fob)
  - A USB memory stick with an antenna
- Integration into one device is the key factor

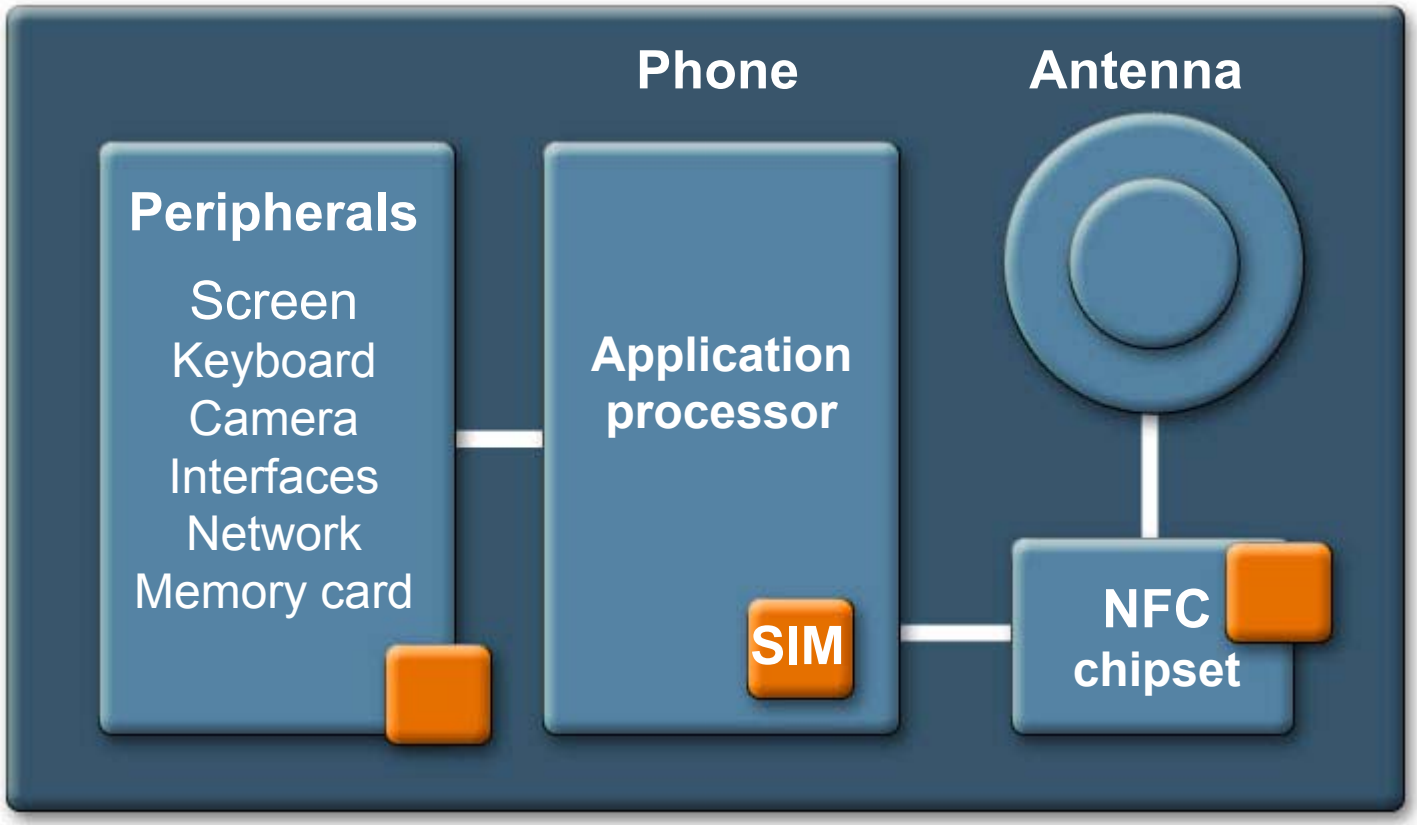
Integrating NFC Into a Mobile Phone



Running Sensitive Applications

- Payment, transport, identity…
  - They are all sensitive applications
  - Usually running on secure smart card cores
  - Can they run on a mobile phone?
- Mobile phones need secure tokens

Adding a Secure Token



Possible Scenario

Evolution of the mobile smart card application

- We start by a standard smart card application
  - Using the phone's NFC interface
- Some interaction is required by the end user
  - User interaction is provided by a MIDP application
  - The application accesses the SIM through JSR 177 or through a standard HTTPS connection
  - A HTTPS connection can also be used with a server
- The smart card application is more complex
  - In particular, it must manage Internet

Possible Scenario

A transport application

- The application is on the secure token
  - With NFC interface, it behaves like a card/token
  - The user can get on the network, buy tickets, etc.
- The application is accessible from the phone
  - The user can buy tickets online, look at the balance
- The application is accessible from the network
  - It can connect to a remote server for maintenance
  - It can be disabled remotely if required

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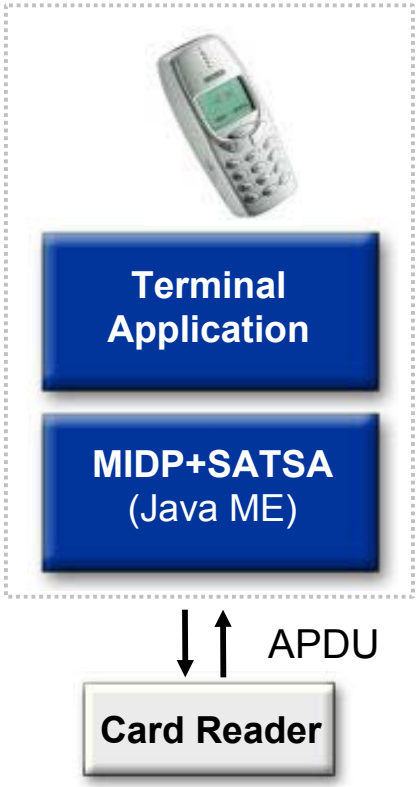
Breaking Away from APDUs

- SIM cards currently use the ISO 7816 protocol (APDU) to communicate with the outside world
- Applications spend a vast portion of time parsing ISO commands
- More powerful smart cards with and TCP/IP connectivity enable a better programming model



Why Put a Web Server Inside a SIM?

- A logical evolution
  - A SIM card is already a server
  - SIM cards with MBs of memory and high speed interface can process and serve rich content
  - Servlets are well known to developers
  - All phones have browsers
- An improved user and developer experience
  - Leverage standardized web protocols to provides security services to the phone user
  - Interact with the use in familiar user interface
  - Leverages existing developer experience

Smart Card Web Servers and Java Card Technology

- The First Generation of SIM card webservers is being standardized at ETSI
  - Based on current generation Java Card technology
  - Can handle simple TCP/IP-based communication
  - Can handle multiple interfaces sequentially
  - Limitations on the size of data objects and arrays
- New chips will bring maturity to the concept
  - Designed for TCP/IP—based communication
  - Bigger and faster devices can handle rich content
  - Opportunity for a more capable Java environment

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Why Do We Need Security?

- Security: defending assets against attackers
- Which assets are we defending?
  - Cryptographic data (keys)
  - Credentials (passwords)
- Against which attackers?
  - The cardholder is a dangerous one
  - A card thief is another

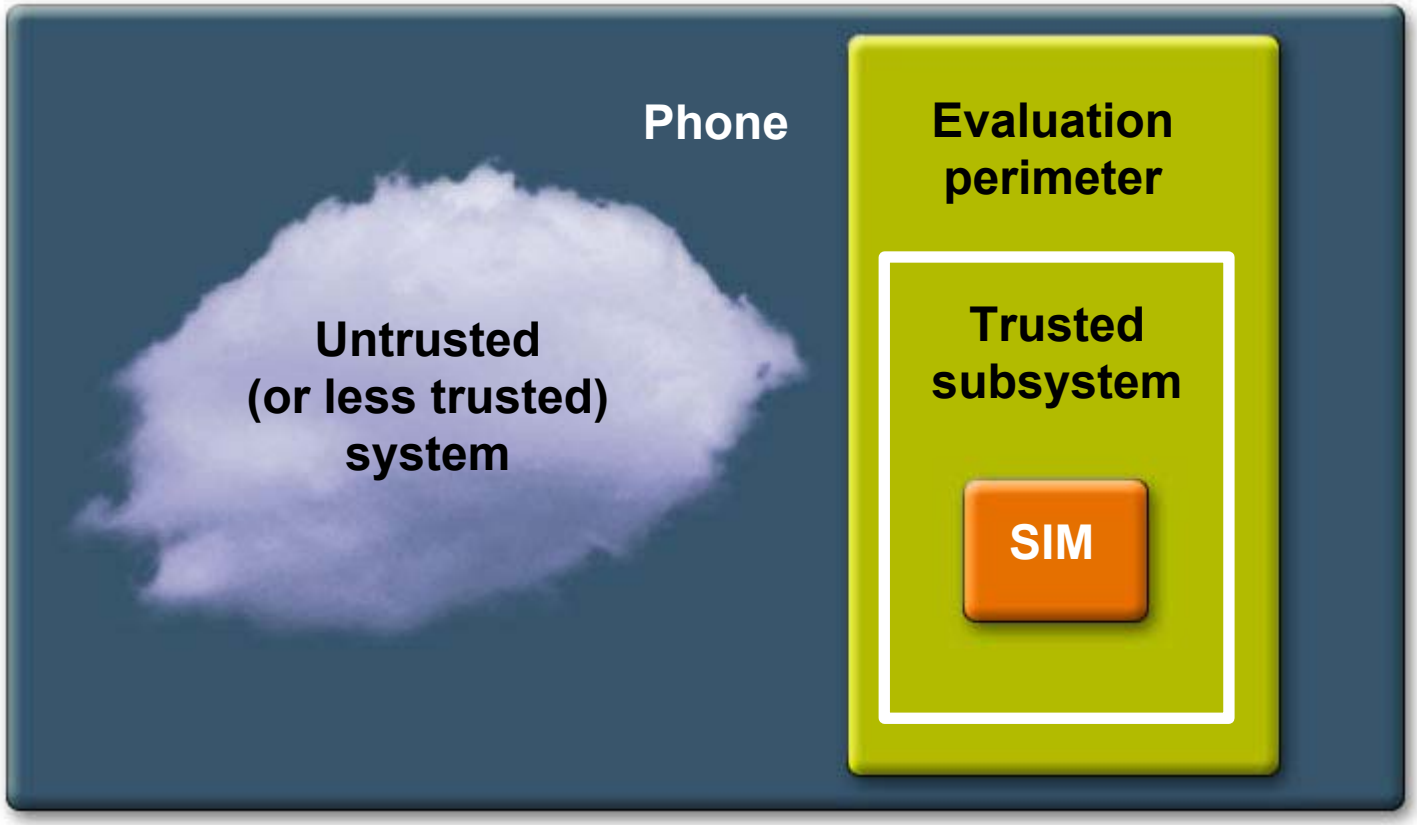
Mobile Phone Security

- Depends a lot on the threat
  - Remote threats are not too bad
    - Not much malware (for now)
    - Especially true for simpler systems
  - Local threats (by owner) quite bad
    - Code base can often be modified
- It is difficult to secure the entire code
  - The smart card can be a root of trust

Mobile Phone vs. Contactless Card

- Contactless cards have some issues
  - They can be abused without the user's consent
- Mobile phones with NFC don't have them
  - It is possible to ask for a confirmation
  - It is even possible to ask for a PIN
- Yes, but ... what is the security level of a phone?
  - Is the data displayed guaranteed to be correct?
  - Can the PIN code be kept confidential?

Smart Card as Root of Trust



Smart Card as Root of Trust

- Smart cards are good roots of trust
  - They provide a reasonably high level of security
  - They are very easy to isolate
- They can minimize the trusted subsystem
  - It can be some kind of a browser
  - The card should then act as a Web server

Why Java Card Technology?

- Because smart cards are secure
- Because Java programming language is a high-level language
- Because it defines a standard interface
  - Platform duties are well identified
  - Application duties are complementary
- Because it is portable
  - We have seen that many architectures are possible
  - A Java Card platform application can be ported easily

Which Duties for Java Card Platform Applications?

- Protect their sensitive assets
  - Keep confidential data protected (encrypted)
  - Verify the integrity of sensitive data
  - Check the execution of sensitive code
- Protect their application interface
  - New interfaces yield new threats
  - Contactless protocols have specific threats
  - Web server architecture bring many threats
    - All classical Web attacks are now feasible
    - The good news is that they are well known

Conclusion—Part I

- New mobile apps demand more from the SIM
- Changes to the role of the SIM and the Handset induce new security constraints
- The Next-Generation Java Card platform architecture must enable new use cases while preserving security

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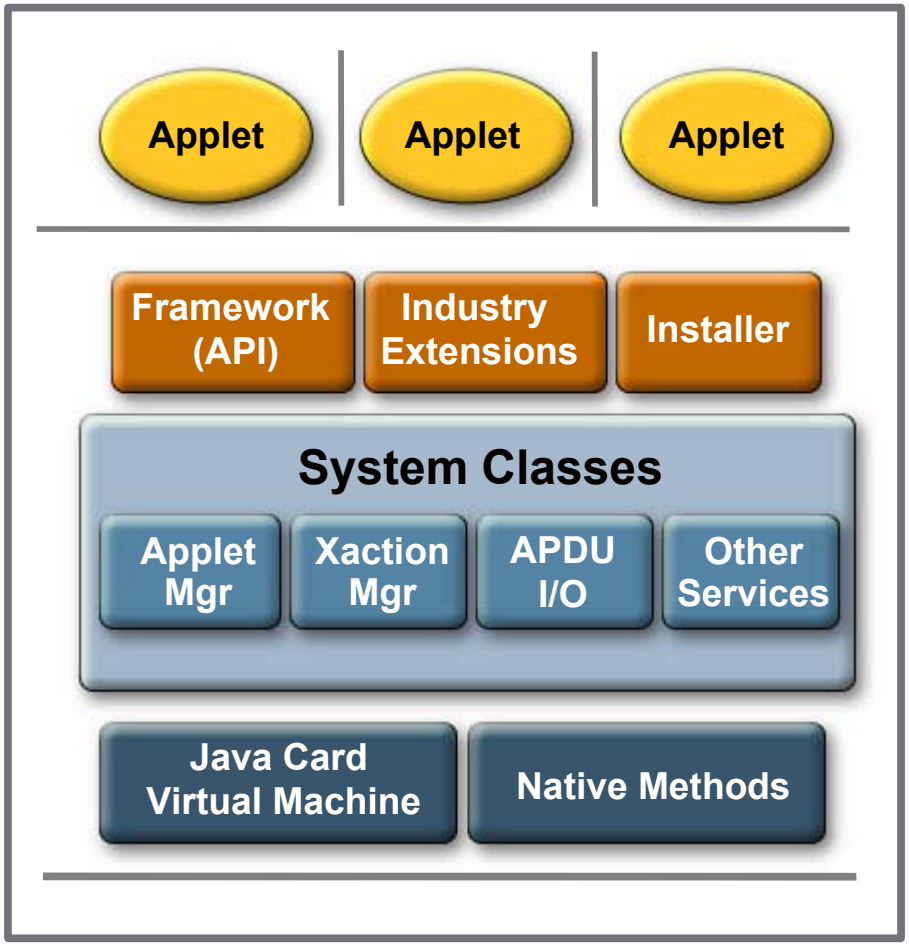
The new wave of mobile applications

Next Generation Java Card technology

- **Overview**
- **Architecture and new features**

Java Card Technology Today

- ***Java Card 2.2.2 Platform Specifications***
- ***Subset of Java™ Platform, Standard Edition (Java SE platform) and Java programming language***
- ***Split-VM Architecture***
- ***Persistent VM model***
- Firewall model isolates contexts and applets
- ISO7816 Communication I/F and protocol
- Transaction management



Drivers for Next Generation Java Card Technology

- SIM cards are in the process of developing from a multi applications smart card platform to a
  Mult-interface network connected secure token
- Technology drivers for a new Platform
  - Adoption of USB and TCP/IP over USB
  - Concurrent contact and contactless interface in parallel
  - Concurrent APDU and TCP/IP based communication
  - Http/Https driven communication for web content

Requirements for Next Generation Java Card Technology

- Support for the emerging usage patterns :
  - NFC, smart card web server
  - Support for new protocols and memory configurations
  - Concurrent support for multiple interfaces
- A development experience on par with Java ME platform
  - More capable and mainstream Java environment
  - Streamlined development tool integration
- Enhanced security features to support a more complex environment

Next-Generation Specifications

- Two stand-alone “Editions” of the Next-Gen Java Card technology specs
- Java Card Platform, **Connected Edition**
  - Includes all new network-oriented features
- Java Card Platform, **Classic Edition**
  - Leverages the existing Java Card 2.x platform architecture
  - For the more resource-constrained devices
- Both Editions are backward compatible with previous versions and share key security features

“Classic” Edition Features

- Traditional split VM
  - Resource efficient, 16-bit on-card VM
  - Off-card conversion for applet size optimization : CAP files
  - On-card or off-card byte code verification
  - On-demand Garbage Collection
- “Classic” Java Card APIs
  - Incremental extension of Java Card 2.2.2 platform framework
- APDU-based communication
  - Contact or contactless

“Connected” Edition Features

- Embedded web server with Java Servlet API support
  - Service static and dynamic content via HTTP(s)
- Multi-threaded environment
- Concurrent communication over USB, ISO, contactless
- Full backward compatibility
- Client and Server communication
- Leverage technology from Java ME platform/Java EE platform

Leveraged Java Technologies

- NG Java Card platform reuse existing Java platform building blocks
  - Proven security, tools, and developer community
- Java Card 2.x platform
  - APDU-based application model and card specific APIs
- Java ME technology
  - Connected Limited Device Configuration (CLDC)
  - Multi-threading, Strings, int, long, multi-dimension arrays
  - Generic Connection Framework, Security Model
- Java EE technologies
  - Java Servlet API for web application model

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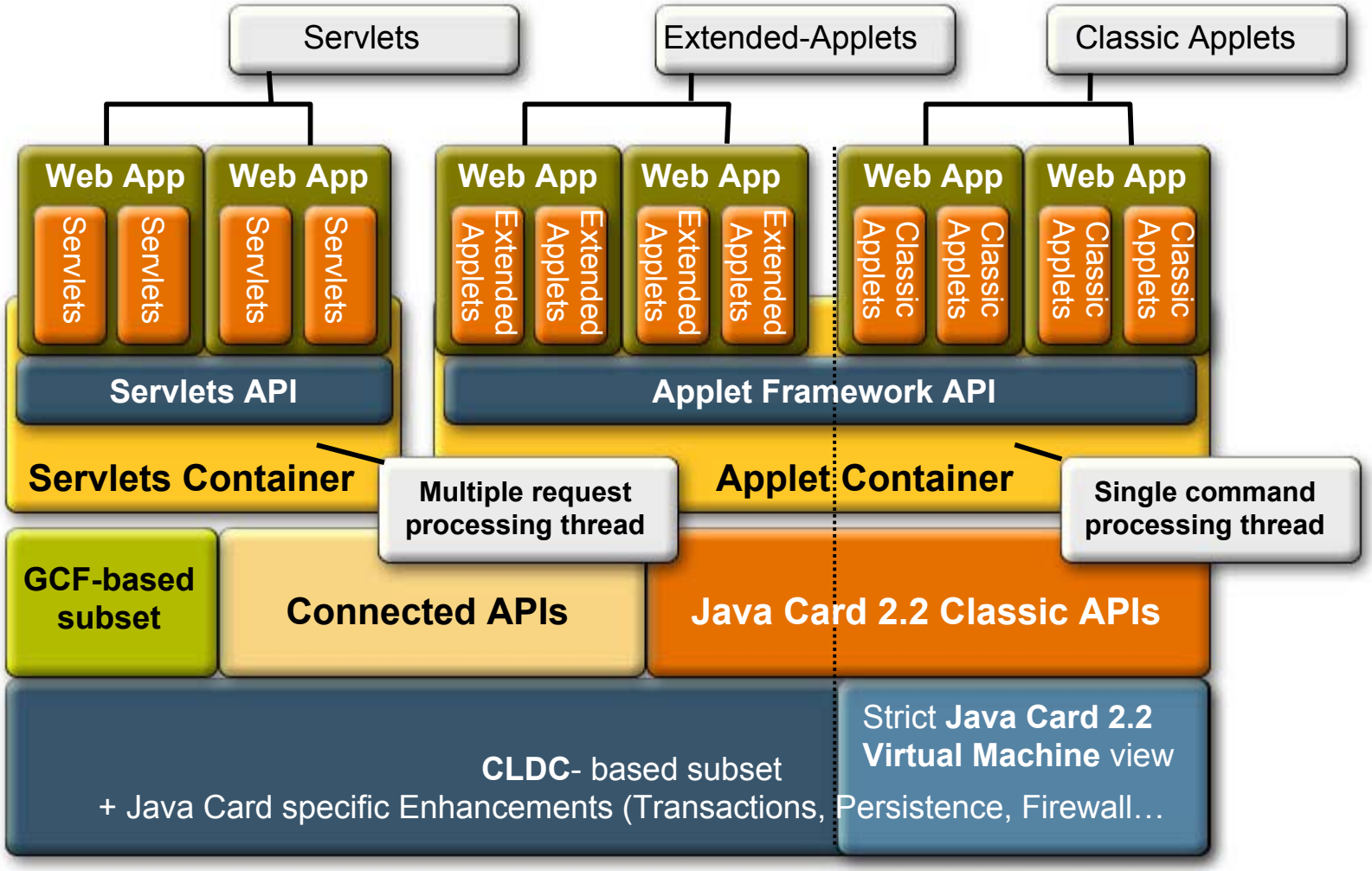
Next Generation "Connected" Java Card Platform



Next-Generation "Connected" Java Card Platform Features

- Virtual Machine Technology
- Security
- Network-oriented Communication
- Enhanced Programming Model

Virtual Machine

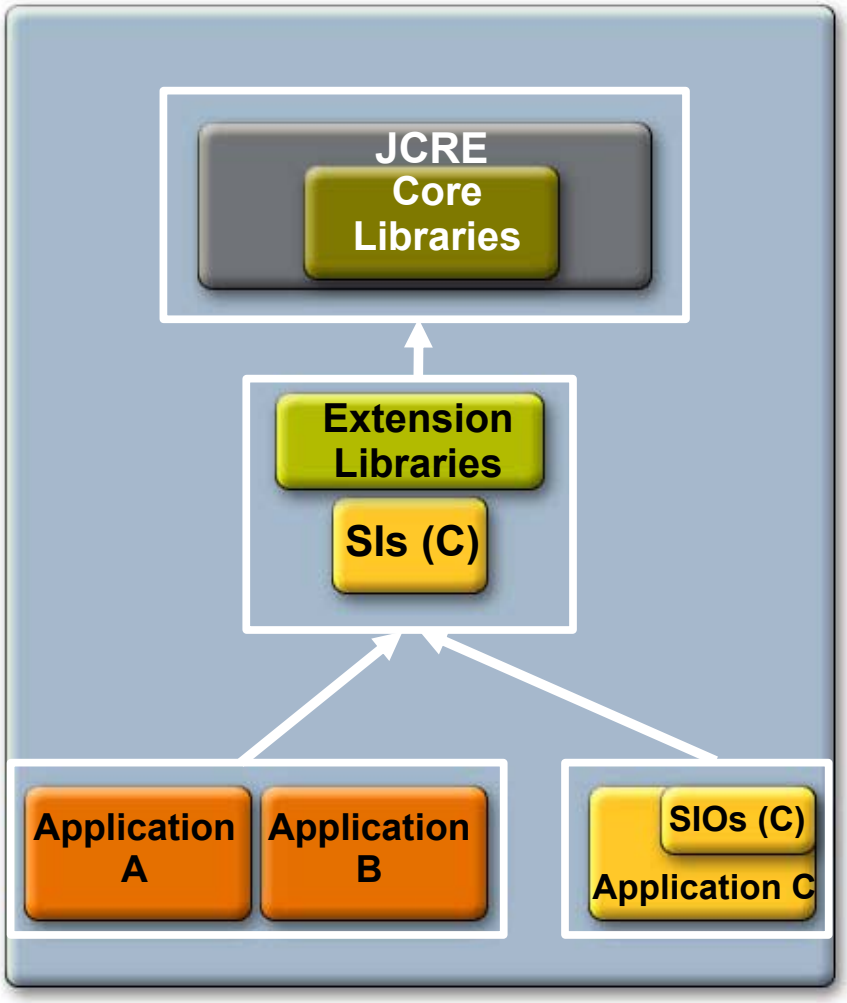
- 32-bit VM
- .class File Loading
- Concurrent execution of applications (Multi-threading)
- On-card bytecode verification
- Automatic Garbage Collection

Security—Overview

- Code isolation
- Context isolation
- Access control
- Authentication
- Enhanced shareable interface mechanism

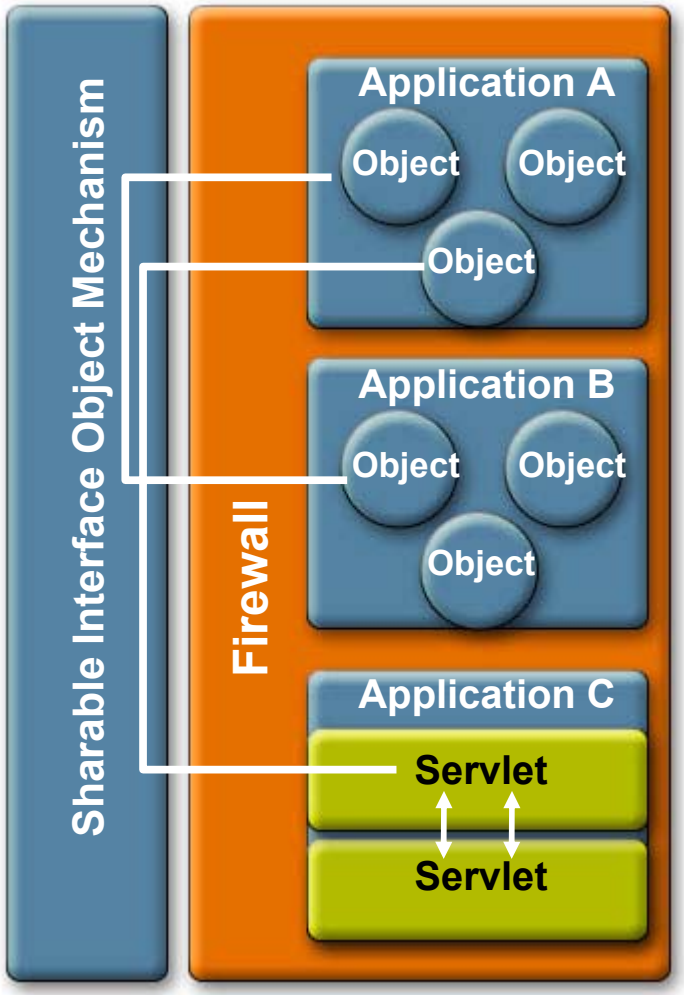
Security—Code Isolation

- Similar to Java SE class Loaders
- Uses 3 principles of Java SE class loader
  - Delegation Principle
    - Delegation to parent first
  - Visibility Principle
    - Classes loaded by parents visible to children but not vice versa
  - Uniqueness Principle
    - When a class is already loaded in the class lookup table path, it is not reloaded



Security—Context Isolation

- Enforced by firewall
- Object Ownership
  - Every object owned by the creator object's context
- Object Access
  - Only allowed from same context
- Context Switching
  - Same as Java Card 2.2.x. platform



Security—Access Control

- Policy based fine grained access control
- Leverages a subset of Java SE platform security model framework
- Protection Domain used to define a set of permissions granted to applications in the domain
- Leverages the firewall (Context Isolation)
- Per application Declarative Security
  - Allows server application to designate the clients it allows to call its service
- Defined by application developer and configured by deployer/application provider

Security—Authentication

- Card holder authentication
  - Global
  - Session
- Remote administrator authentication
- Container managed authentication

Network Oriented Communication

- ISO 7816 and TCP/IP communication support
- Communication over USB, MMC
- Concurrent contact/contact-less card access
- Embedded web server
- Service static and dynamic content through HTTP(s)
- Client and server communication mode
- Generic communication API

Enhanced Programming Model (1)

- Fully backward compatible
- Support additional Java platform language types
  - Char, long... and String
  - Multi-dimensional arrays
- Support for large data structures—Multimedia content
- Application models
  - Classic APDU-based applet model
  - HTTP Servlet-like model

Enhanced Programming Model (2)

- Enhanced inter-application communication framework
- Generic event framework
- Evolutive cryptography

Summary

- More complex card applications and deployment schemes
- Advancements in smart card hardware need corresponding changes to the Java Card platform
- Next-Generation Java Card Platform:
  - Fully backward compatible
  - Enhanced VM
  - Advanced security features
  - Network-oriented communication support
  - Advanced Programming Model

For More Information

- Java Card technology booth in the exhibition hall
- TS-5203: Web 2.0 Applications on a Next-Generation Java Card Platform
- TS-0285: JavaCard for Emerging WLAN Environments
- TS-5147: Free Mobile-to-Mobile Money Transmission
- TS-5642: What to do with APDU?
- BOF-0396: Internet Application Use Cases of Next-Generation Java Card Technology
- BOF-5593: Contract Enforcement for Embedded Java Technology Programs

Q&A

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