Mobile Computing
#MC07 Device Management

## CS60002: Distributed Systems
Winter 2006-2007

Today

- ✔ Device databases
  - Flash, OR/direct
- ✔ Synchronization
  - Algorithms
- ✔ Push/notifications
  - Scale to MM
- ✗ Handheld design
  - CPU, RTOS, battery

- ✗ Core Mobile Apps
  - Email/IM, PDA,browse
- ✔ IP Protocols
  - IMS
- ✔ Broadcast
  - Algorithms
- → Device Management
  - Software & Config

Agenda

- ## What is Device Management?
  - Definition, Example
- ## Standards and Products
  - OMA-DM, Startups
- ## Constraints
  - Access rights, memory, bandwidth, ...
- ## Algorithm
  - In-place reconstruction

Device Management (DM)

- What?
  - Update mobile
  - Over-the-air (OTA)

- Why?
  - Firmware upgrade
  - Software distribution
  - Service provisioning
  - Diagnostics
  - Application data

Example: DM for MS Mobile

http://technet.microsoft.com/en-us/library/bb737271.aspx
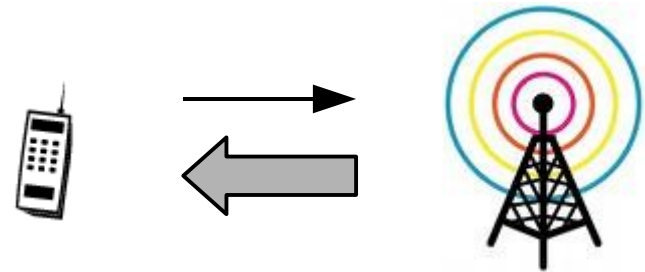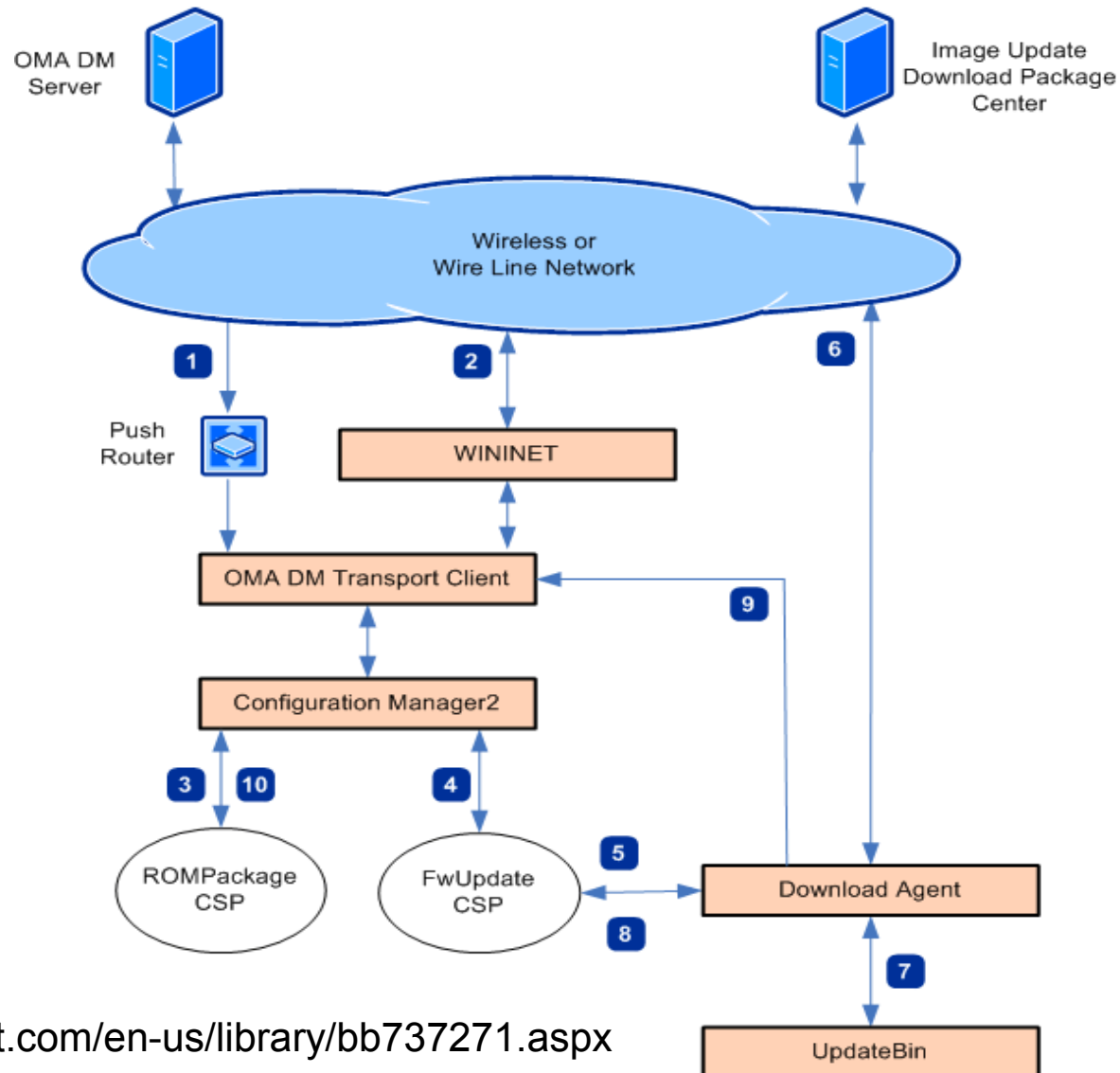
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OMA-DM

- Open Mobile Alliance - Device Management
  - Originally developed by SyncML Initiative
  - Specifies protocols and Object Model

- DM Specs
  - Protocols
    - Bootstrap, Device Management, Representation
  - Management objects: 3 mandatory
    - DMAcc, DevInfo, DevDetail
  - Additional information
    - http://www.openmobilealliance.org/Technical/release_program/dm_v1_2.aspx

Products

- Lots of startups
  - Bitfone, BrightPoint, InnoPath, Insignia, mFormation, MobileThink, Perelgo, RedBend, Sicap, SmartTrust, Synchronica,WDSGlobal, ...

- Plus, mature players
  - Ericsson, Motorola, Nokia, ...
  - HP, IBM, Microsoft, ..

- Shared challenges
  - 18 month lifecycle for mobiles
  - Frenetic pace of development

Constraints

- Shared with PC upgrades
  - Access control
  - Scheduling
  - Patch computation
  - Atomicity

- New or emphasized in mobile computing
  - Backup/restore
  - Bandwidth
  - Memory

DM and Access Control

- **Who can manage?**
  - User
  - Employer/Parent
  - Wireless carrier
  - OS/Firmware vendor
  - Device manufacturer

- **Role management**
  - Applications
    - User, Employer
  - Service provisioning
    - Employer, Carrier
  - Bugfix, new features
    - Carrier, OS Vendor
  - Critical bugfix
    - Carrier

DM and Scheduling

- Imagine 4B mobiles * 1GB memory each

  - That will be a lot of data to manage OTA

    - We are not that far off!

    - Scheduling is important

  - Remember, PC's do not share spectrum!

- Resources to schedule

  - Carrier networks

  - Coverage (roaming), battery

  - User and employer constraints

DM and Patch Computation

- How to transform V2.3 to V2.4?

  - See your notes from lecture MC03: Synchronization

  - "Three problems in code sync"

    - Small patches

    - Data compression

    - Patch application

  - Rsync, prefix sort, bsdiff

- But, not every mobile has the same V2.3!

  - Older versions. Updates to V2.3. Optional modules.

DM and Patch Computation

- Patch "pre V 2.4" to V 2.4
  - Problem similar to PC updates
  - But, bandwidth, cpu & battery are more constrained

- Strategies
  - Digital hashes as shorthand for device configuration
  - Maintain LRU cache of patches at Server
  - Wait until mobile docked to PC over USB/Bluetooth

DM and Atomicity

- Incomplete DM => Brick!

  – Restore to a known state on failure

- Three phases

  ✔ Authentication and Identification (interrupts are ok)

  ✔ Downloads (interrupts are expected)

  ➔ Update (interrupts can be fatal)

- How to make update atomic?

  – Ensure conditions needed for success

  – Rollback on failure

DM and Atomicity

- Ensure conditions needed for success
  - Ensure battery
  - User confirmation and UI lock
- Rollback on failure
  - Technical challenge
  - Similar to atomicity in database products, but ..
    - Without machinery like write-ahead logs
    - With more stringent memory limitations
  - Blackboard discussion (time permitting)

DM and Backup/Restore

- Backup before DM, restore after DM
    - Mobiles not considered reliable persistent store
    - Obviate reformatting of data on mobile
- Challenges
    - Size of backup/restore
        - May resort to USB, not OTA
    - Potential for lost updates during the DM operation
   - Security of backups

DM and Bandwidth Optimization

- Avoid backup/restore

    – Reformat data in-place

    – Or serialize/deserialize

- Minimize size of patch files

    – See discussion of bsdiff in an earlier lecture

- Data compression

    – But, respect CPU and battery on mobile

- There is always USB!

DM and Memory Constraints

- Disclaimer
  - Dropping Flash prices may obviate this in future
- Memory on mobiles
  - Often managed by firmware/software
    - .. that is being upgraded!
  - Often near 100% utilization
    - Thanks to digital cameras
- DM with memory constraints
  - Perform updates "in-place"

rsync recap
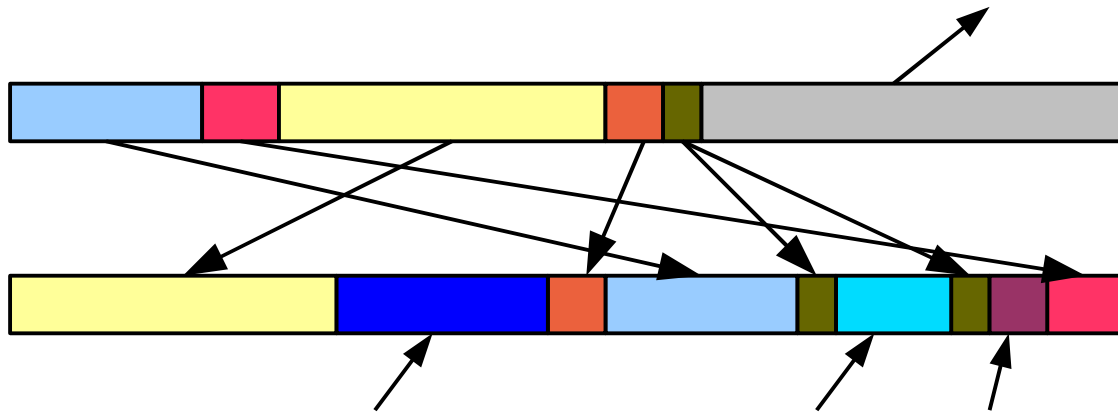
File synchronization problem

– Bob wishes to have Alice's copy

– Should Alice just send the whole file to Bob?

– No. rsync can help

- Andrew Tridgell, Paul Mackerras, "The rsync algorithm", http://rsync.samba.org/tech_report/tech_report.html

Read-write interval conflict
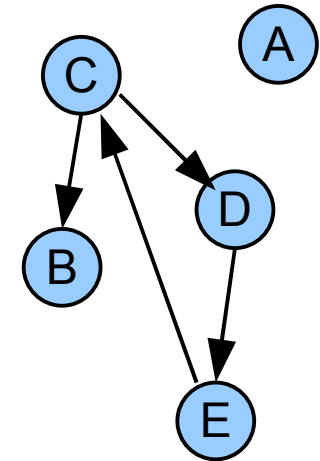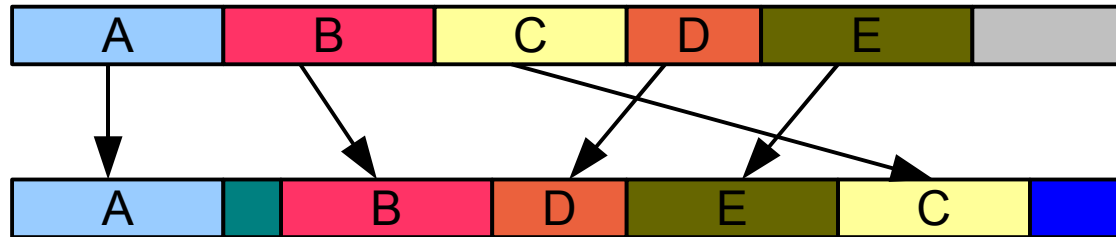
- CRWI graph
  - Conflicting read-write intervals
  - Copy commands are nodes
  - Directed edges (C, B) and (C, D) denote that copy(C) must precede copy(B) and copy(B)
  - Imposes a partial order on the copy commands

Cycles in CRWI Graph

- Denote circular dependency of copy commands

- How to break cycles?

  - Eliminate nodes

    - Replace a copy command by a bulky add command
    - Or, concede use of temporary storage

  - Trim nodes

    - Break C into parts C'+C''; only one conflicts with D

- Breaking cycles adds communication

  - Add commands are bulkier than copy commands
  - Can we find an optimal way to break cycles?

Breaking Cycles

- General digraphs

  - Feedback vertex problem is NP-Complete (Karp 72)

- Optimal communication w/o in-place constraint

  - Can be done in polynomial time

- What about CRWI digraphs?

  - Still NP-Complete

  - Maybe CWRI is not the right formulation

  - Optimal communication w. in-place is NP-complete!

In-place reconstruction heuristics

- They work well in practice
  - Linear time graph traversal (say, DFS)
  - Simple heuristics (e.g., delete smallest copy node)
  - But, no linear bound on increased communication
- Reading assignments
  - Optional
    - "In-Place Reconstruction of Version Differences", Burns, Stockmeyer, and Long
  - Required
    - "In-Place Rsync: File Synchronization for Mobile and Wireless Devices", David Rasch and Randal Burns

Recap

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  - Reading assignment