

Technologies for Future Mobile Networks

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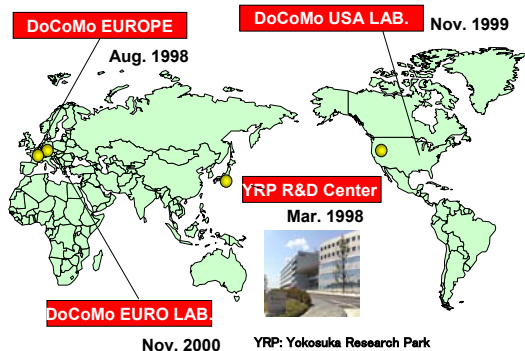


Content

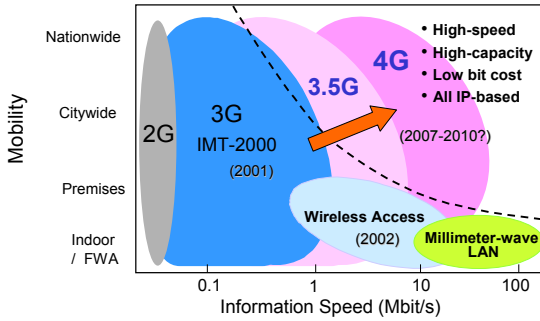


- UMTS / 3G Mobile networks and beyond
 - Mobile market in Japan
 - Future directions and 4G
- Mobile Networks architecture
 - Programmability in mobile networks
 - Active Networks and cross layer interfaces
 - Software defined radio

NTT DoCoMo's R&D-Centers



4G Mobile Communications Systems



4G Requirements

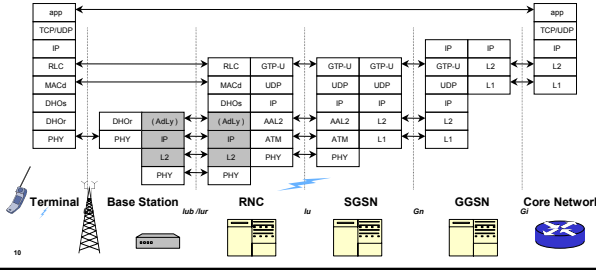
- Huge Multimedia Traffic Handling
- Diversified Radio Access
 - Cellular, wLANs, ad-hoc networks, ...
- Seamless Service
 - Network seamless
 - Terminal seamless
 - Context seamless
- Advanced Mobility Management

Content

- UMTS / 3G Mobile networks and beyond
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- Mobile Networks architecture
 - 3G system architecture and future requirements
 - Programmability in mobile networks
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3G System Architecture

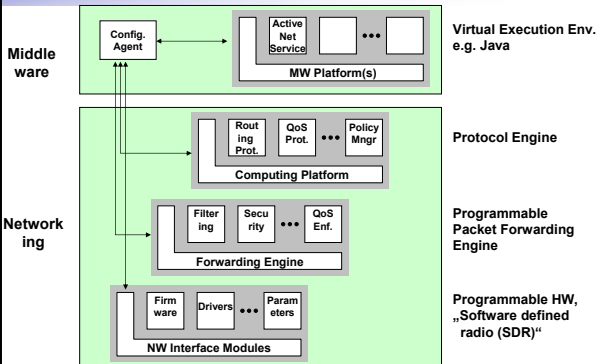
- 3G protocol architecture is complex
 - Mixture of IP and ATM technologies
 - Offers voice & data services



Technical Goals for Future Networks

- Simple and universal networking protocols
 - IP networking as basis
 - Separate evolution of components
 - access, core, MW, radio
 - SW platforms and programmable components
 - Fast service creation and optimizations
- More flexibility and programmability is the key

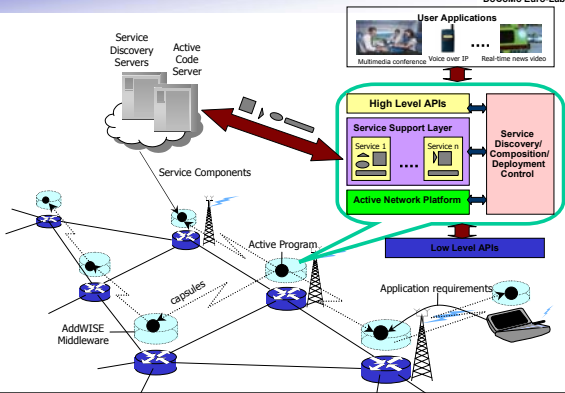
Programmable Network Element Model



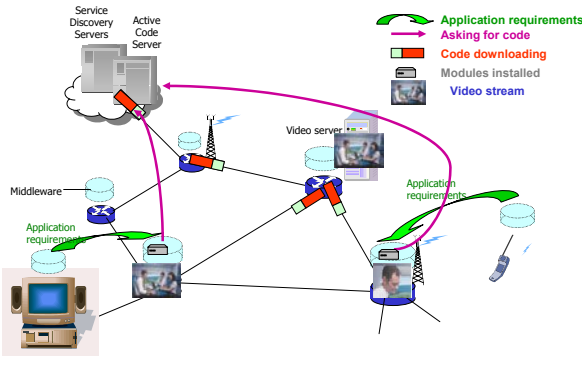
Active /Programmable Networks

- Active Networks offer flexible networking protocols by
 - Programmable execution environments (EE)
 - APIs to lower layers and applications
- Execution environment(s) can be on different layers
 - EEs on data path, signaling or middleware layer
 - Typically lower layers filter packets to be processed by EE
- Code deployment infrastructure
 - Alternative is "code in packets" or capsules approach
- Many implementations, few standards (IEEE PIN)

Active Network Architecture



Example Application for Active Networks



Classes of Reconfiguration



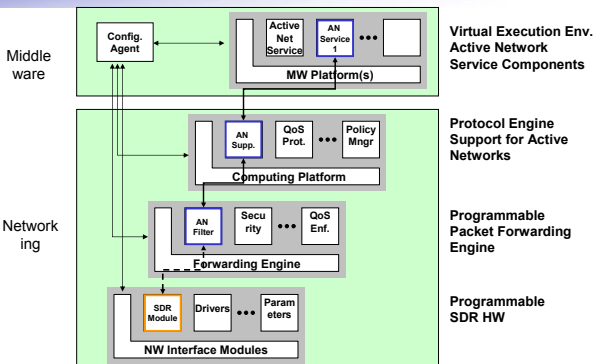
1. Parameterization of SW/HW modules
 2. Complete SW update
 - E.g. firmware update
 3. SW update of a component or a software module
 - Correct function of the complete software has to be reconsidered
 4. Open, virtual execution environment
 - Platform takes care of component
 5. Capsules approach
 - Program code is contained in packets
- } SDR
- } Active Networks

Driving Forces for Programmability



- Beyond 3G requirements
 - Flexible service and application development
 - Separate evolution cycles of individual components
 - Integration of heterogeneous environments
- Programmable platforms instead of fixed APIs
 - Update components & interfaces
 - Standardize platforms instead of protocols
- Enable cross-layer awareness for mobile networks
 - Essential for fragile mobile networks
 - E.g. hand-over, fading

Cross Layer Interfaces for SDR & AN



Cross-layer interfaces

- Cross-layer interfaces used for optimizations
 - Mobility, quality, security
 - Often media or application specific and evolve fast

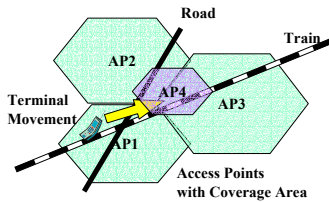
Application areas

- Additional information about the network,
 - e.g. possible bandwidth or delay variations
- Notification of imminent changes in the network services
 - e.g. hand-over or QoS degradation
- Notification of changes in the network service
- Information from the applications including user context
- Configuration APIs

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Example: Context-aware hand-over

- Currently, new access point (AP) is decided by signal strength
 - Not sufficient for overlapping networks
- Find optimal AP by user context
- Examples
 - User in car or train
 - Preference for specific service of AP2
- Decision should be taken locally for performance



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Examples of Cross-layer Interfaces

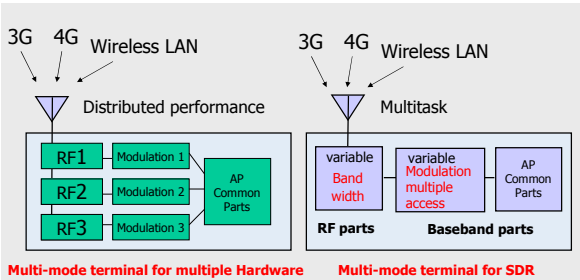
- Mobility management for a group of terminals moving in the same way
 - Users are traveling in a train / car
- Customized multicast
- Quality of service
- Context-aware hand-over and paging

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Motivation for Software Radio

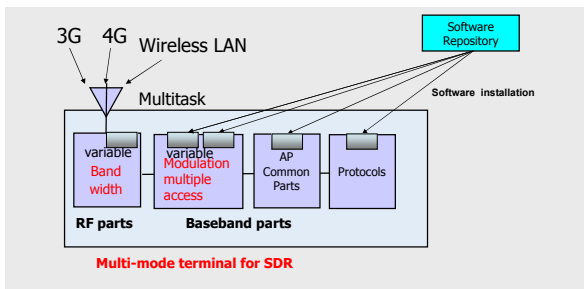
SDR (Software Defined Radio) is enabled by programmable RF and baseband hardware



Multi-mode terminal for multiple Hardware Multi-mode terminal for SDR

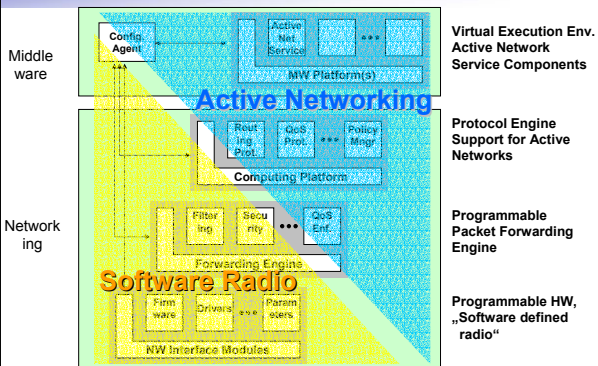
What is Software Radio?

- Reconfiguration by installation of new software



Multi-mode terminal for SDR

Programmable Network Element Model





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