Advancing 3GPP Networks: Optimisation Techniques to Support Smart Phones

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Background –
Application Network Efficiency Task Force

■ Task Force created end of 2011 following requests from CEOs of Bharti, Etisalat, KT, Rogers, TeliaSonera, Verizon and VimpelCom

■ Problem to be addressed:
   – Smartphone behaviour due to OS and 3rd party Apps, in particular Advertising and Messaging/Social Network apps.

■ Several activities active in parallel under the Task Force
   – Guidelines for application developers to create network friendly apps
   – Network Optimisation
   – Push Server requirements

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Objectives of Network Optimisation White Paper

- To identify key issues related to network inefficiencies caused by smartphones/tablets and applications running on them

- To identify possible solutions which require a degree of joint and aligned industry action

- To provide a compendium of solutions that can be deployed by individual operators based on the problems encountered in the network

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Results - Categories of Optimisation

- **Small Data Packet Transmission:** e.g. status messages; location messages; presence updates; instant messages; keep-alives; etc

- **Network Initiated Traffic:** e.g. push services like advertisements, service notifications, video clips; Software/Firmware upgrades or patches; etc

- **Video Services:** e.g. live/on-demand video streaming; video clip download, upload, messaging; video monitoring; Real-time communication

- **Access Network Changes:** e.g. Change of access technologies between UMTS and LTE, between 3GPP and non-3GPP due to mobility; Shifting applications from one access to another access due to user preference, operator policy; etc

- **Group based features:** e.g. Subscription information by application, by device type, by OS type; Group-based addressing; Software upgrade notifications; etc

- **Application/Device Monitoring:** e.g. Monitoring by device category, by application; Location/presence updates; Detection of distributed denial of service attacks; etc

Results - Information provided in the White Paper

■ Some context/background is provided for each Optimisation Category

■ Possible solutions have been clearly identified and given an identifier (like a requirements ID)

  – E.g. VS-1: Video Services, solution 1
  – This allows the document to be used as a baseline for any other working group or SDO.

■ For each solution the document includes a detailed description

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Small Data Packet Transmission -
Problem statement

- As smart phone usage proliferates, aggregate volume of data as well as signaling amount increases exponentially

- Most wireless data transactions consist of transmission of small data packets
  - The causes for this are multiple: Social Networking application, WebRTC, advertising in free downloadable apps, keep alive messages

- Problematic consequences:
  - Frequent transitions between idle and active states generate further network signaling
  - Pushing update to online "friends" multiplies the transactions
  - UE battery is heavily solicited

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Small Data Packet Transmission - Groups of solutions

- ■ Network or UE implementation specific mechanisms
  - – SD-1 and SD-2
- ■ Network Parameter configuration
  - – SD-3 and SD-4
- ■ Over the top mechanisms
  - – SD-5a and SD-5b
- ■ 3GPP radio features
  - – SD-6 to SD-13

Network Initiated Traffic –
Problem statement

- Push traffic is associated to Advertisements, Service notifications, multimedia messaging services, Software/firmware upgrades or patches.

- Potential problems:
  - Large burst of push data can lead to user plane congestion
  - Dense and simultaneous push services in a local or wide area may cause the network congestion in control plane (as UE's need to be brought into active state) and consequent service break.

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Network Initiated Traffic – Opportunities for improvement

- Intelligently scheduling of push data

- Broadcast/multicast mechanisms when universal/group distribution applies

- Longer active state retention without adverse battery lifetime impact.
  - Using suitable Radio level techniques in UE/RAN.

- Optimization of paging traffic vs. mobility management traffic tradeoff
  - More precise information for slow moving/fixed UE's

- Small cells
  - Placing stationary or quasi stationary UE's on Small cells and using paging optimization in this layer may relieve the macro RAN layer from paging traffic

Network Initiated Traffic – Groups of solutions

- **Network or UE implementation specific mechanisms**
  - NT-1

- **Network Parameter configuration**
  - NT-2 to NT-6

- **Over the top mechanisms**

- **3GPP radio features**
  - NT-7 to NT-11

Video Services –
Problem statement

- **Challenge:**

  Cost of transporting and delivering video is much greater than the cost of traditional services such as voice or SMS

- **Video Services under consideration:**

  - Live and on-demand video streaming

  - Video clip download/upload/messaging

  - Video monitoring

  - Real-time communication

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Video Services –
Groups of Solutions

- Content Adaptation
    - Compression VS-1; VS-15
    - ABR VS-2;
    - Right sizing (network resource adaptation)
      VS-11; VS-19; VS-32
    - Pacing VS-9
    - Routing/Mobile CDN VS-29
- Caching:
    - Network VS-5
    - Queued VS-22

- QoS management:
    - Bearer creation VS-4
    - QCI prioritisation
      VS-10; VS-24-25
    - OneAPI: VS-20; VS-28
- WiFi/Small Cell augmentation
  VS-3; VS-7; VS-8; VS-12; VS-27
- Delivery technology – DASH/Multicast:
  VS-3; VS-6; VS-14; VS-17-18; VS-30
- Access Control: VS-21; VS-31
- Network Release: VS-26

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Access Network Changes –
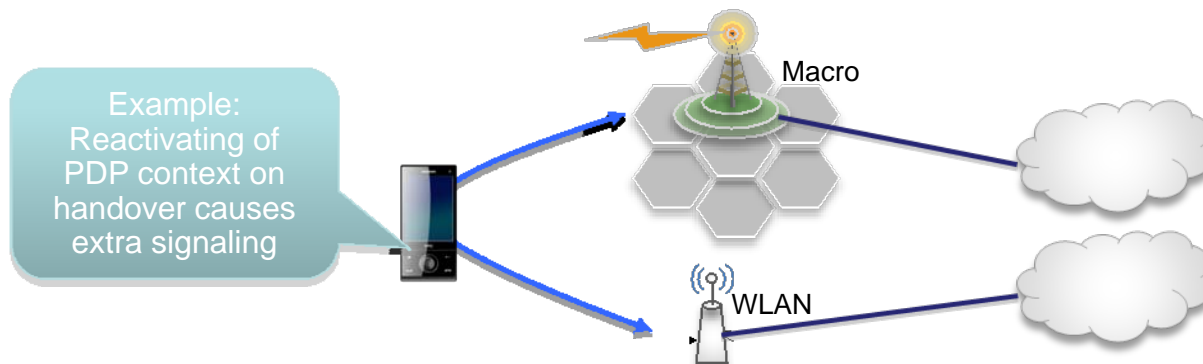# Problem Statement

- Additional coverage and capacity needed to augment network
- WLAN as a possible solution but some challenges
  - Adds to signaling load on AAA / HSS
  - Mobility between WLAN and 3GPP impacts experience
  - Selection of appropriate WLAN network
- Potential solutions
  - Network Selection – Assist UE for optimal WLAN selection
  - Automatic Authentication based on 3GPP EAP for WLAN (HS 2.0)
  - Seamless Mobility across RATs and maintain session information

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Network Considerations

- Additional enhancements to 23.402 for optimal and effective mobility

- Trusted and Untrusted Networks to be addressed

  - 24.312 provides for ANDSF based network selection

  - Enhancements needed for HS 2.0

  - More Network control recommended vs. UE selecting WLAN

- Large file download via macro network restricted

  - Network intervention needed when UE doesn't connect to WLAN

- Avoid ping-pong between Macro and WLAN

UE Considerations

- Reduce ping-pong behavior

- Ability to manage security credentials

  – Reduce signaling due to re-authentication

- Currently UE based proprietary solutions possible

  – Needs enhanced network based solutions

- UE behavior could result in control plane overloading

Example: Reactivating of PDP context on handover causes extra signaling

Macro

WLAN

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Group based features –
Problem Statement and Use cases

- For use with devices and applications that can easily be grouped to enable optimization of network resource usage
    - Group based triggering (e.g. software update notification)
    - Group based policing
    - Group based monitoring (e.g. data usage monitoring)
    - Group based communication (e.g. for public safety users)
    - Group based charging

Group based Features – Main considerations

- ■ Benefit of applying group based features depends on optimal grouping of devices.

- ■ Possible criteria for grouping
    - – Location
    - – Application running in the device
    - – Owner of the device
    - – Similar features subscribed and supported by the device

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Application / Device Monitoring – Problem Statement and Use cases

- **Monitoring is an essential feature for the following reasons:**
    - To enable the network react to misbehaving devices, misbehaving apps by device category, application category etc.
    - Devices can be deployed in remote areas and in locations where they are not monitored actively by humans, probability of theft and vandalism is really high.

- **Monitoring events**
    - Misbehaving devices, misbehaving apps, etc.
    - Location changes, presence updates, etc.
    - Using above network information to trigger services
    - Detection of distributed denial of service attacks

BACKUP

Small Data Packet Transmission – Solutions

- SD-1: Network socket request manager
- SD-2: Network proxy
- SD-3: Authentication/network tuning
- SD-4: Overload control
- SD-5: Application development guidelines
- SD-6: UMTS Rel-99 feature: URA_PCH with DRX same as RRC-Idle
- SD-7: UMTS Rel-7 feature: DTX/DRX in active mode (CELL_DCH)
- SD-8: UMTS Rel-8 feature: Network controlled UE triggered Fast Dormancy
- SD-9: UMTS Rels-7 and 8 features to enhance operation in CELL_FACH

- SD-10: LTE DRX
- SD-11: MBMS for synchronized DL small data sent to large amount of UE's
- SD-12: UMTS release 11 feature on Further Enhancements to CELL_FACH
- SD-13: LTE release 11 feature on Diverse Data Application

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Network Initiated Traffic – Solutions

- NT-1: Push server
- NT-2: Smart management of Tracking Areas and small cell layers
- NT-3: Retain mobiles in connected mode
- NT-4: Retain mobiles in connected mode when IMS is used
- NT-5: Authentication Tuning
- NT-6: Overload Controls

- NT-7: Release 7 Improvements to CELL_FACH; Release 8 Network controlled Fast dormancy
- NT-8: MBMS
- NT-9: OMA BCAST
- NT-10: UMTS release 11 feature on Further Enhancements to CELL_FACH
- NT-11: LTE release 11 feature on Diverse Data Application

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Video Services – Solutions

- VS-1: Video Compression

  e.g. H.264 video compression

- VS-2: Adaptive Bit-Rate Adoption

- VS-3: Client content caching and network off-load

- VS-4: Application based QoS control

- VS-5: Network-based Caching

- VS-6: eMBMS

- VS-7: Offload Solutions (WLAN, femto/small cells)

- VS-8: Femto/Small cells

- VS-9: Service based throttling

- VS-10: Network assigned priority

- VS-11: Enhanced RAN-Core interaction

- VS-12: Cells on Wheels (COWs) & EPC in box

- VS-13: UE Function changes – timing mechanisms to access the network for unicast services

- VS-14: DASH

- VS-15: Video Compression (e.g. HEVC)

- VS-16: Client Caching

- VS-17: DASH Improvements

- VS-18: Network-assigned Capacity

- VS-19: Optimization based on congestion awareness

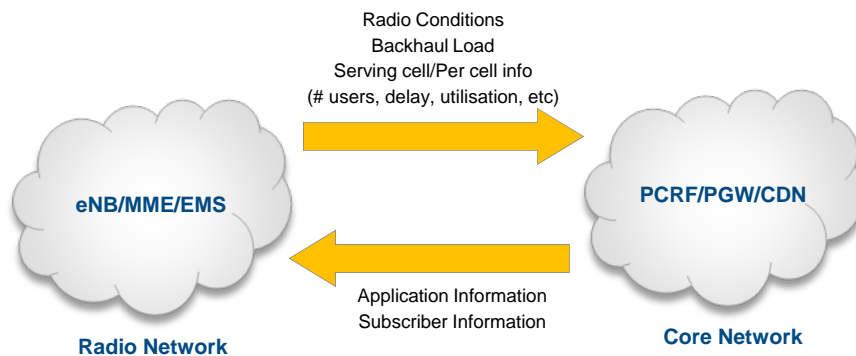- VS-20: Application API / OneAPI

- VS-21: Content Authorization

(contd.)

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Video Services – Solutions (contd.)

- VS-22: UE function changes – OS or connection manage to synchronise broadcast content
- VS-23: Offload solutions
- VS-24: Trusted 3rd party access - Rx
- VS-25: UE OS and browser for closer application integration
- VS-26: Negotiate end of transmission
- VS-27: Network augmentation
- VS-28: Trusted 3rd party access – network API
- VS-29: Content context routing

- VS-30: Network-based content availability
- VS-31: OMA Dynamic content delivery
- VS-32: RAN congestion handling

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Video Services – Long-term Solutions

- Network Augmentation
- Content Context Routing
- Network-based Content Availability
- RAN Congestion handling

Radio Conditions
Backhaul Load
Serving cell/Per cell info
(# users, delay, utilisation, etc)

eNB/MME/EMS

PCRF/PGW/CDN

Application Information
Subscriber Information

Radio Network

Core Network

- Open-loop model (dependent or independent one-way communication model) (completely within operator control)
    - RAN (eNB/MME/EMS) -> PCRF/PGW/CDN/other new function
    - RAN (eNB/MME/EMS) <- PCRF/PGW/CDN/other new function
- Closed-loop model (two-way model) (completely within operator control)
    - RAN (eNB/MME/EMS) <-> PCRF/PGW/CDN/other new function

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Access Network Changes – Solutions

- AN-1: Context maintenance
- AN-2: WLAN access point selection
- AN-3: WLAN quality estimation
- AN-4: Battery life optimisation
- AN-5: Transition with fast re-authentication
- AN-6: Offload mechanisms
- AN-7: Study enhancements/optimisations for congested WLAN accesses
- AN-8: Study integration/interworking between 3GPP and WLAN mobility and security control
- AN-9: ANDSF enhancements to support Hotspot 2.0

Group Based Features – Solutions

- GF-1: Cell broadcast
- GF-2: MBMS Broadcast to groups of devices in a particular location (3GPP TS 36.331)
- GF-3: Enhance cell broadcast services for LTE
- GF-4: Globally unique group identifiers in the subscription data
- GF-5: Group based charging using group identifier as a correlation identifier
- GF-6: Group based policing for all devices that are connected to the same P-GW/GGSN
- GF-7: IP Multicast for groups of devices in a particular location running the same application (3GPP TS 23.246)
- GF-8: Group based triggereing/Group based paging

Application/Device Monitoring – Solutions

- AD-1: Usage monitoring
- AD-2: Enhanced charging records
- AD-3: Usage monitoring feature for general data usage
- AD-4: Enhancement in packet core network to monitor additional events

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