







# LTE network modelling in STEM with a glimpse on life cycle costing

STEM User Group Meeting 2012 Kings College, Cambridge, UK

Chemnitz University of Technology
Communication Networks

Thomas Martin Knoll knoll@etit.tu-chemnitz.de

https://www.life-cycle-costing.de/STEM/

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### **Overview**

- MEVICO project recall
- "Universal" LTE model
- Backhaul alternatives
- Life Cycle Cost modelling
- Summary / Outlook









# **MEVICO** project

# "Mobile Networks Evolution for Individual User Experience"

- EU Celtic Call 7 project
- European consortium of about 25 partners in 10 countries
- Project Co-ordination: Nokia Siemens Networks, Finland
- Ends by End of 2012 / Later in 2013
- Focusses on LTE EPC and Backhaul network

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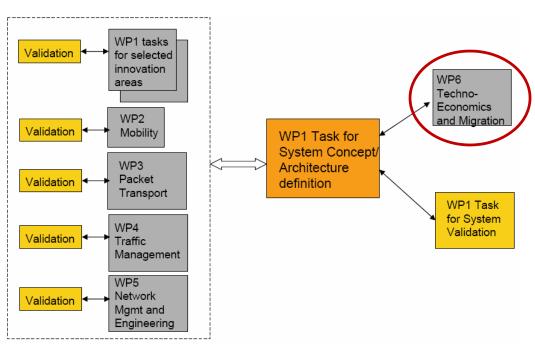








### MEVICO tasks → WP 6



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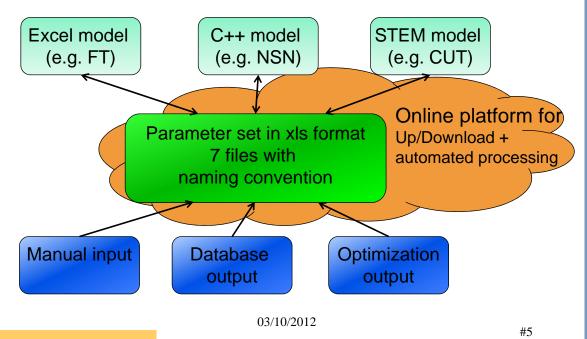






### **Current approach**

#### Parameter set in xls format





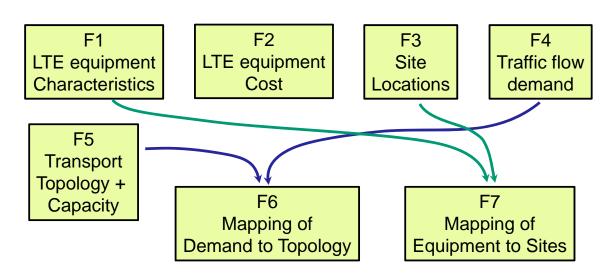






# **Current approach**

7 Excel files as parameter set



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### Live Demo of the model

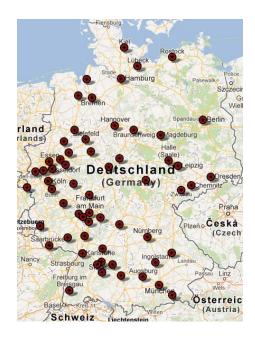
POP locations in Germany

http://maps.google.de/maps?q=http:%2F%2Fwww.tu-

chemnitz.de%2Fetit%2Fkn%2Fteam%2Fkn oll%2FPOP%2520Scenarios%2520German y.kml&hl=de&z=6

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 MEVICO Darmstadt model in STEM



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### **Backhaul alternatives**

#### Layer 1 alternatives

- Microwave
  - SDH,
  - Hybrid,
  - Ethernet only
- Fibre
  - own fibre,
  - fibre reach (up to eNodeB?)
- Leased Line
  - LL provider selection (price, reachability)
  - SLA & QoS agreements









### **Backhaul alternatives**

#### Layer 2 alternatives

- Ethernet variants
  - Rapid Spanning Tree (RSTP)
  - Multiple Spanning Tree (MSTP)
  - Shortest Path Bridging (SPB)
  - Transparent Interconnect of Lots of Links (TRILL)
  - Provider Backbone Bridging Traffic Engineering (PBB-TE)
  - 802.1ad support ("Double VLAN tagging")
- Generic Framing Procedure (GFP)
  - Single link aggregation over p2p connection

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### **Backhaul alternatives**

#### Layer 2,5 alternatives

- Multi-Protocol Label Switching (MPLS)
  - Widely used in core, new to access / aggregation
  - Statistical packet aggregates with "engineered" paths
- MPLS Traffic Profile (MPLS-TP)
  - Pseudo-wires over end-to-end LSPs
  - Similar to PWE3
- Seamless MPLS
  - Consistent IP/MPLS deployment
  - Ideally between eNodeB and gateways

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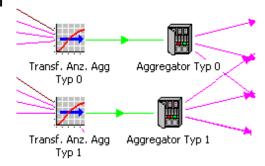






### **Backhaul alternatives model**

- Definition of key network elements
- Definition of main transport path alternatives
- Using traffic forecasts
- Using technology roadmaps
- Consideration of migration scenarios



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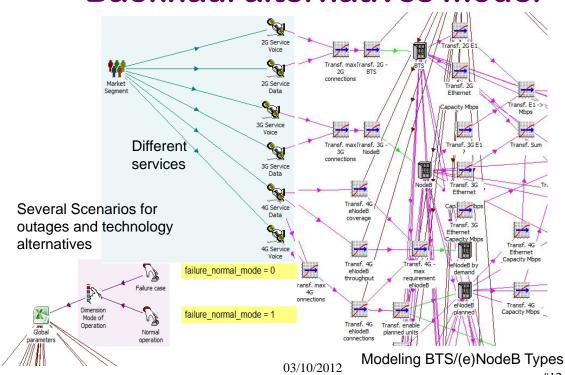








# **Backhaul alternatives model**





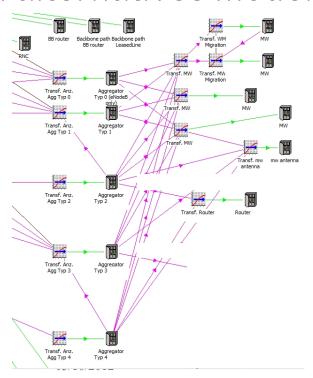






### **Backhaul alternatives model**

Modelling access and aggregation locations and network equipment by means of Aggregator Types 0 .. 4 with L1 and L2 equipment for scenarios with different alternative solutions



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### **Backhaul alternatives model**

- Results on expected concentrator load + outlook how long SDH microwave can cope with it
- Modelling of fibre leased line interconnections to drain traffic and achieve SDH ring life span extension
- CAPEX / OPEX trade-off for near-by vs. far-off leased line interconnects among several LL providers
- Evaluate partially meshed access networks for better demand distribution
- L2 vs. L2.5 migration decision









- Initial and acquisition cost and follow-up cost of whole life cycle of products and services "womb to tomb" cost
- Early design or investment decisions lay down the major proportion of follow-up cost irreversibly
- Typical product life cycle phases:
  - research and design phase,
  - production phase,
  - implementation and deployment phase,
  - operation phase and
  - decommissioning phase.

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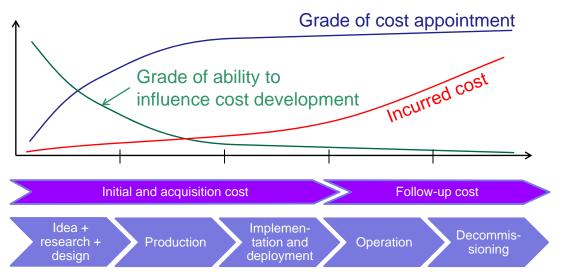






# **Life Cycle Costing - LCC**

Figure of LCC phases and cost appointment



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#### Ways of LCC modelling in STEM

- Argument and sub sum the phase cost so that a single "ordinary" STEM model with aggregated initial cost and follow-up cost results
- 2. Create a single STEM model, but reflect on the phases by introducing + grouping + naming of additional model elements e.g. resources for planning, patent checking ...
- Create separate models (possibly steered by Excel VBA)

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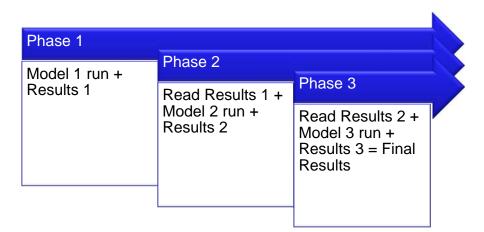




# **Life Cycle Costing - LCC**

#### Ways of LCC modelling in STEM

3. Create separate models - Test example



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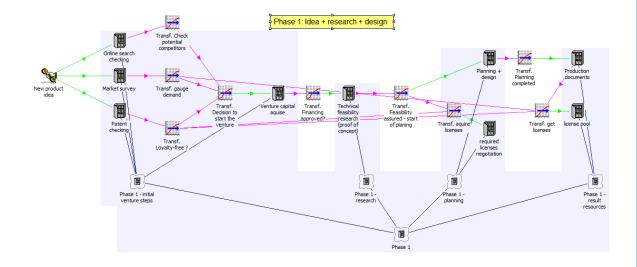








#### → Demo in STEM



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# **Life Cycle Costing - LCC**

#### Open questions

- Consecutive phases vs. overlapping phases (costs of previous phase in Y0 vs. time series with time lag of overlap years)
- Best "interface paths" being
  - Cost Index for cost values,
  - planned units for installed units etc. ?
- Different time scale in phases (months, quarters, years) possible?

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#### http://www.life-cycle-costing.de/

#### English Standards for LCC assessment and calculations

- SAE ARP 4293 Life Cycle Cost Techniques and Applications
- ASTM E917 ASTM E917 05(2010) Standard Practice for Measuring Life-Cycle Costs of Buildings and Building Systems
- ISO 15663-1:2000 Petroleum and natural gas industries -- Life cycle costing -- Part 1: Methodology
- ISO 15663-2:2001 Petroleum and natural gas industries -- Life-cycle costing -- Part 2: Guidance on application of methodology and calculation methods
- ISO 15663-3:2001 Petroleum and natural gas industries -- Life-cycle costing -- Part 3: Implementation guidelines
- ISO 15686-5:2008 Buildings and constructed assets -- Service-life planning -- Part 5: Life-cycle costing
- <u>TAM04</u> Total Asset Management of NSW Treasury

#### English References for LCC modelling and calculation

- Whole Life Cost Forum Whole Life Cost Forum focuses on the Life Cycle Costing application in the construction sector
- www.life-cycle-costing.de collection of LCC Terms, Standards, References and Tools with German and English focus
- <u>IEEE Sustainable Systems and Technology (ISSST)</u> paper on "Reducing lifecycle energy use of network switches"

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### **STEM** related wishes

- 60 field limitation of user data
- Tabs in text boxes
- Import/Export with "txt" files (e.g. .csv, .xml)
- Links to Excel cells in time series
- "chaining" of STEM models









# **Summary / Outlook**

- STEM serves well the purpose
- Sharing with partners should be easier
  - → want to learn more on Online-STEM
- Model base for Transmission System, Switch and Router models
- SDN + Virtualization in mobile networks
  - → single network element models
  - → business case models (new market players)

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