

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

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Kings College, Cambridge, UK

Chemnitz University of Technology  
Communication Networks

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<http://www.life-cycle-costing.de/STEM/>

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#1

## Overview

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

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#2

# MEVICO project

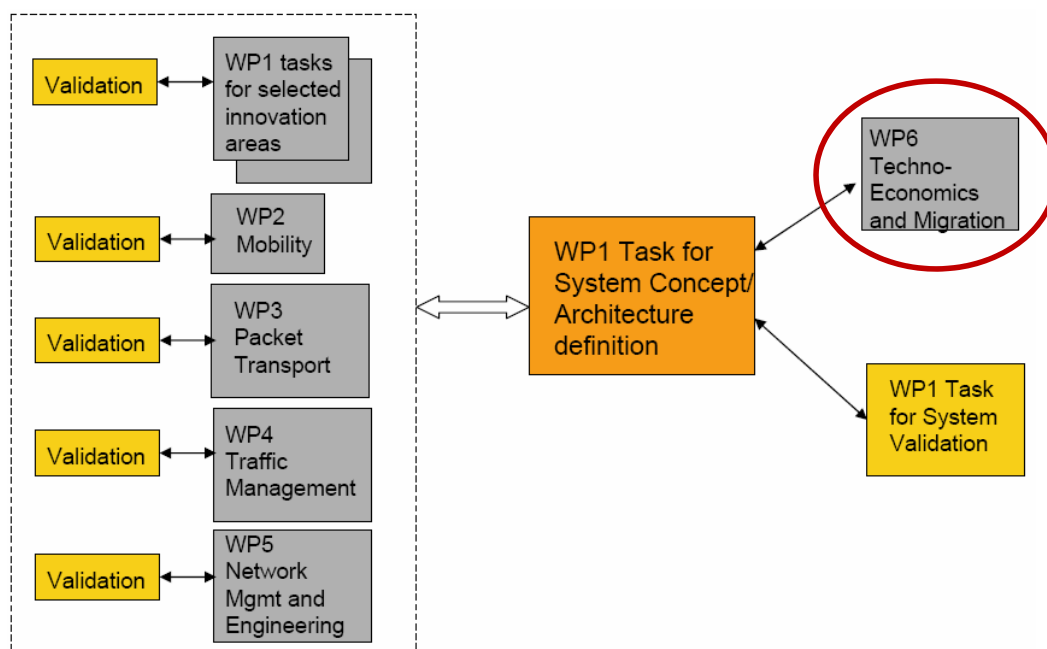
## “Mobile Networks Evolution for Individual User Experience”

- 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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#3

## MEVICO tasks → WP 6

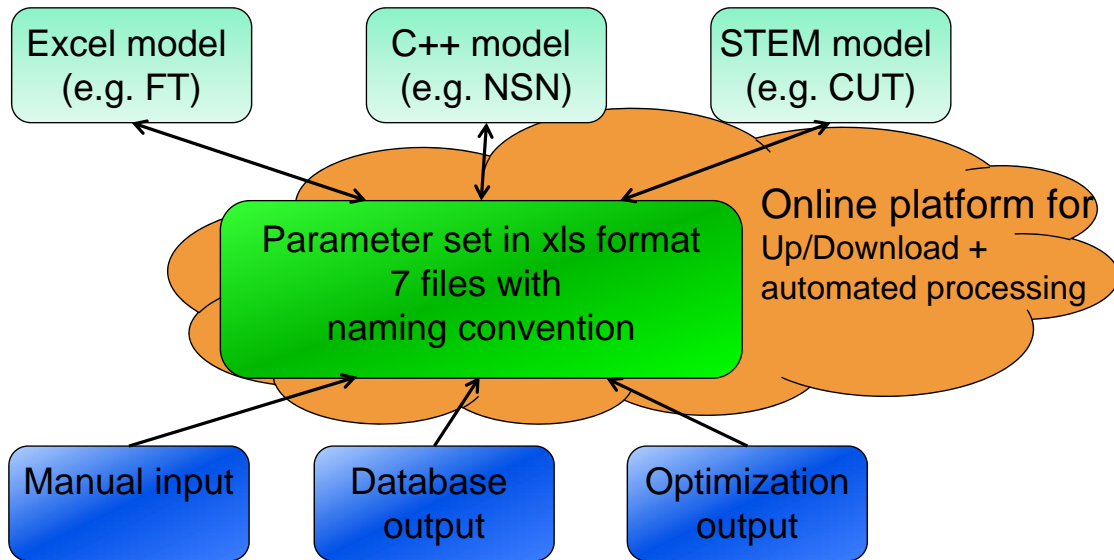


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#4

## Current approach

Parameter set in xls format

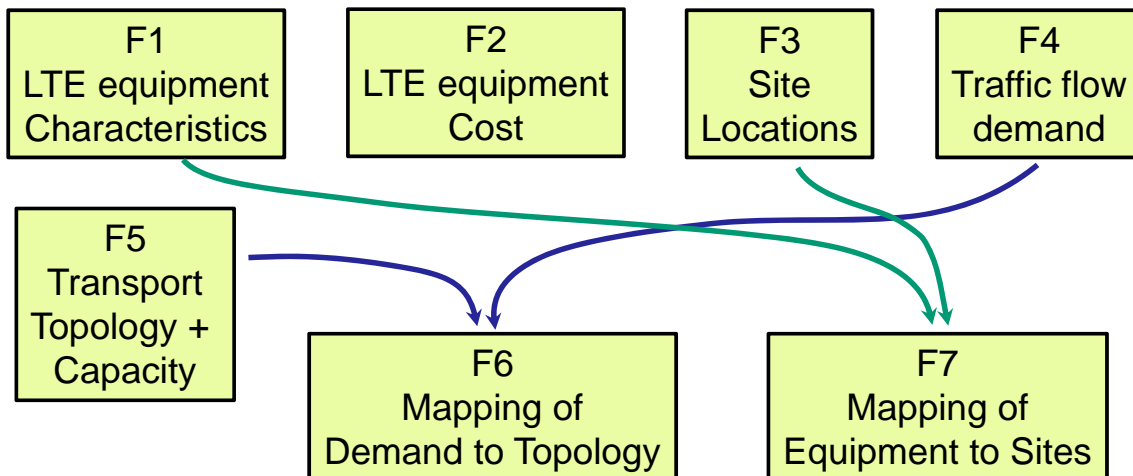


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#5

## Current approach

7 Excel files as parameter set

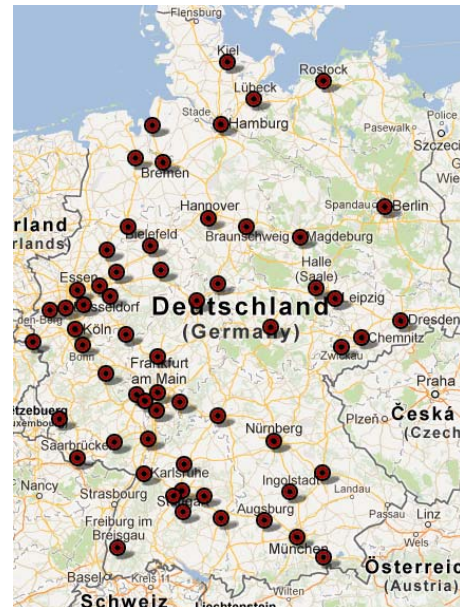


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#6

## Live Demo of the model

- POP locations in Germany  
<http://maps.google.de/maps?q=http:%2F%2Fwww.tu-chemnitz.de%2Fetit%2Fkn%2Fteam%2Fknoll%2FPOP%2520Scenarios%2520Germany.kml&hl=de&z=6>
- &
- MEVICO Darmstadt model in STEM



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#7

## 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

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#8

# 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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#9

# Backhaul alternatives

## Layer 2,5 alternatives

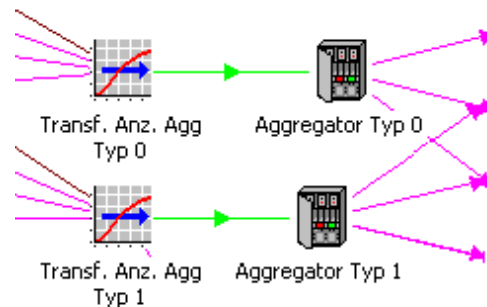
- Multi-Protocol Label Switching (MPLS)
  - Widely used in core, new to access / aggregation
  - Statistical packet aggregates with “engineered” paths
- MPLS Traffic Profile (MPLS-TP)
  - Pseudo-wires over end-to-end LSPs
  - Similar to PWE3
- Seamless MPLS
  - Consistent IP/MPLS deployment
  - Ideally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

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#10

# Backhaul alternatives model

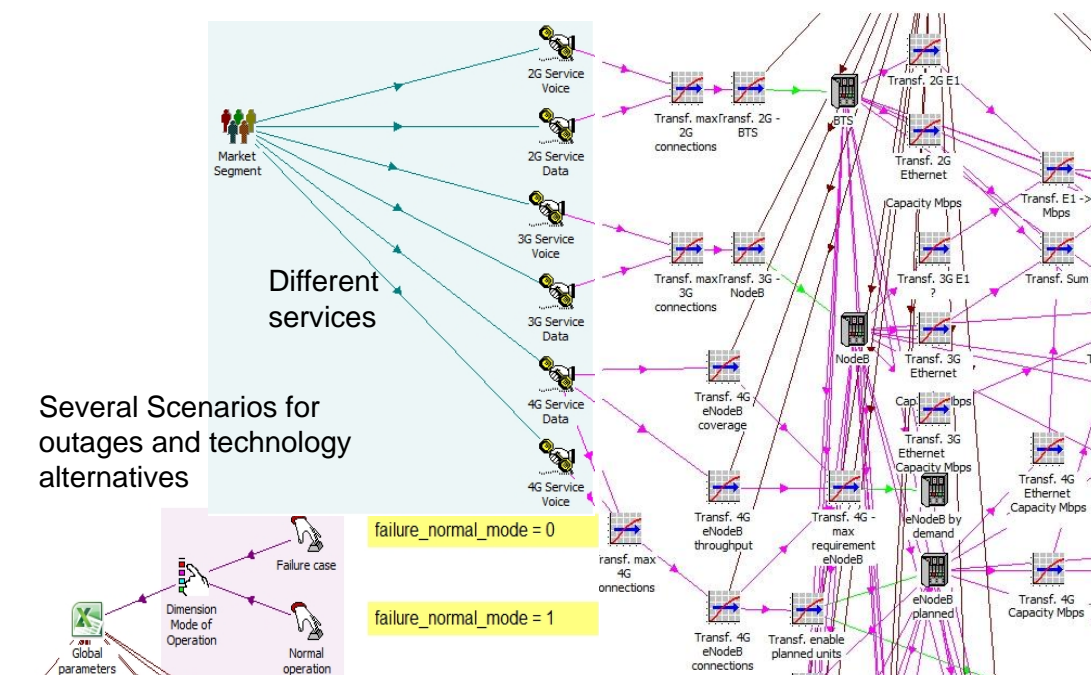
- Definition of key network elements
- Definition of main transport path alternatives
- Using traffic forecasts
- Using technology roadmaps
- Consideration of migration scenarios



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#11

# Backhaul alternatives model



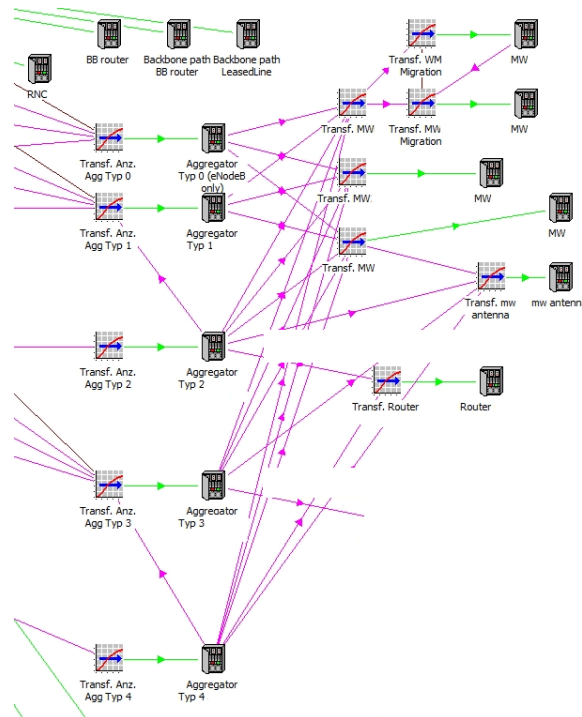
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Modeling BTS/(e)NodeB Types

#12

# 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



#13

# 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

## Life Cycle Costing - LCC

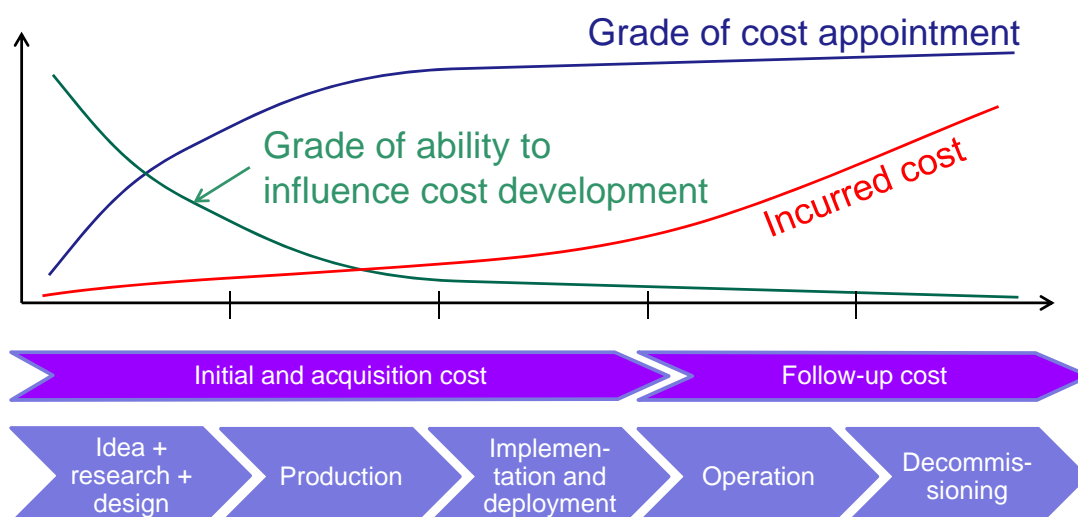
- Initial and acquisition cost and follow-up cost of whole life cycle of products and services  
“womb to tomb” cost
- Early design or investment decisions lay down the major proportion of follow-up cost irreversibly
- Typical product life cycle phases:
  - research and design phase,
  - production phase,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

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#15

## Life Cycle Costing - LCC

- Figure of LCC phases and cost appointment



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#16



# Life Cycle Costing - LCC

## Ways of LCC modelling in STEM

1. 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 ...
3. Create separate models (possibly steered by Excel VBA)

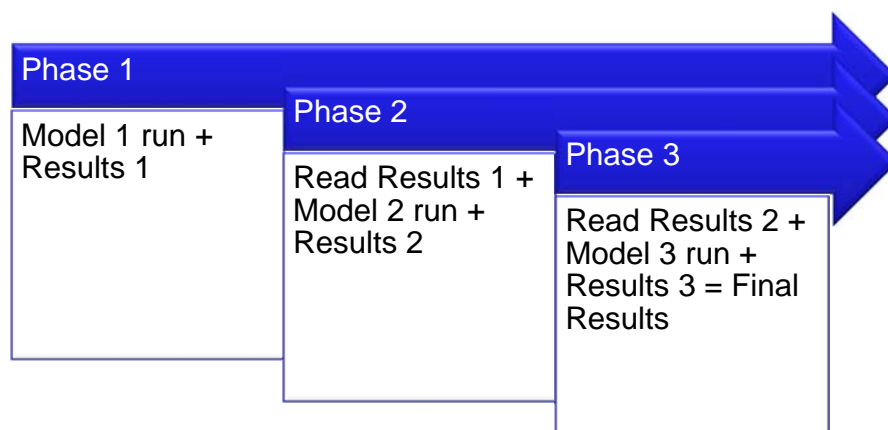
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#17

# Life Cycle Costing - LCC

## Ways of LCC modelling in STEM

3. Create separate models - Test example

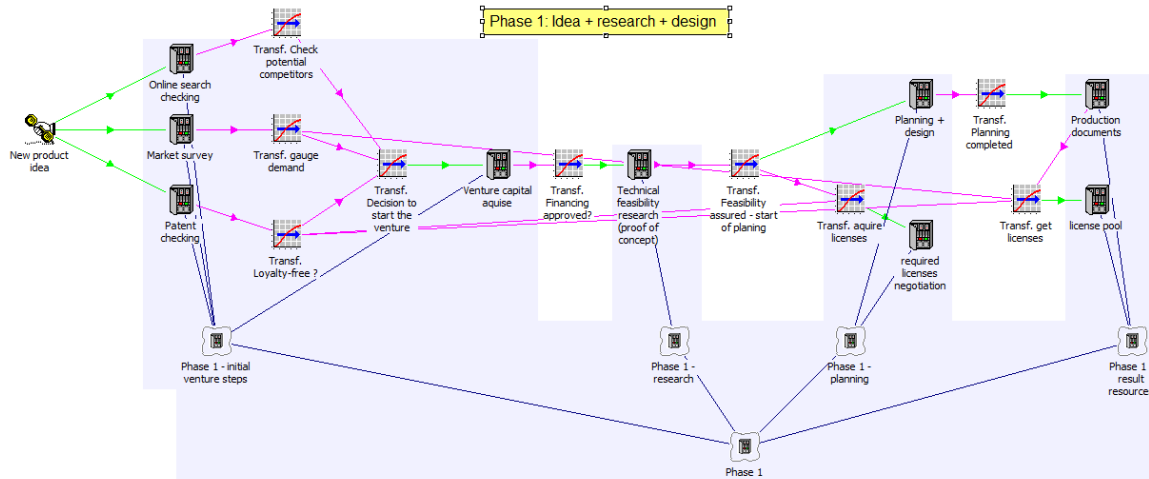


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#18

# Life Cycle Costing - LCC

→ Demo in STEM



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#19

# 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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#20

# Life Cycle Costing - LCC

<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
- [TAM04](#) - 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](http://www.life-cycle-costing.de) - collection of LCC Terms, Standards, References and Tools with German and English focus
- [IEEE Sustainable Systems and Technology \(ISSST\)](#) - paper on "Reducing lifecycle energy use of network switches"

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#21

# 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

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#22

## 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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#23