



# Innovative Contact Line solutions made by Siemens

Increasing operational speed, improving project excellence  
and optimization of life cycle costs

Dehli 2017/10/27

**Siemens is the right partner to accelerate projects and to force technical improvements to reach the ambitious goals in upgrading, enhancing and extending RE infrastructure.**

**Tenders based on functional requirements will result into competitive (new) solutions based on less technical restrictions.**

# Sicat platform

Contact line systems for every task – tailored based on requirements

Apart from economy, longevity and consistently high quality are the key features of the Sicat contact line systems.

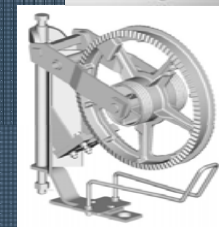
They permit a high running quality, long service life, low LCC and comply with both national and international standards.

Siemens – with more than 138 years experience electrical railways - is releasing an adjusted OCL system for projects based on Sicat platform solution. Therefore all requirements could be met (e.g. PAN, environment, operational & RAMS requirements, ...).

Running speed	DC	AC
≤ 80 km/h	Sicat 3S	–
≤ 120 km/h	Sicat LD	–
≤ 160 km/h	Sicat SD / Sicat SR	Sicat LA / Sicat SR
≤ 250 km/h	Sicat HD	Sicat SA / Sicat SX
> 230 km/h	–	Sicat HA

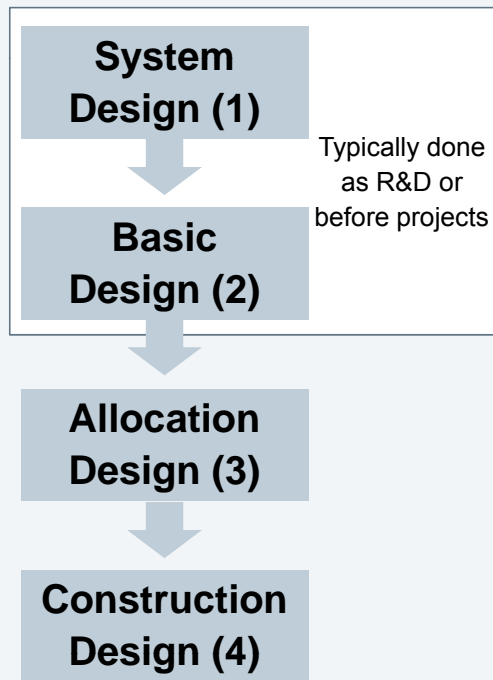
consist  
of

**Sicat 8WL (EN 50119/IEC 60913 tested!)**  
Sicat CMS, Sicat DMS, Sicat PMS, ...

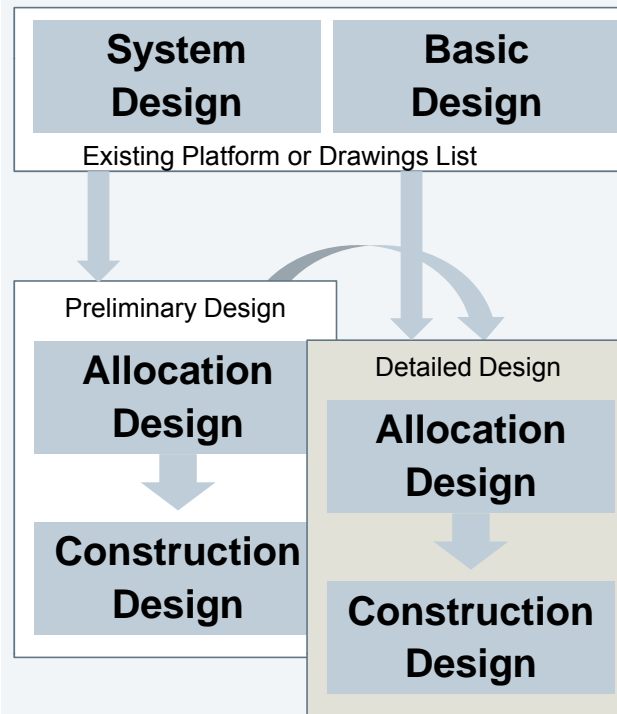


# Multiple Engineering steps have to be done so release a tailored OCL and to proceed afterwards with Detailed Design!

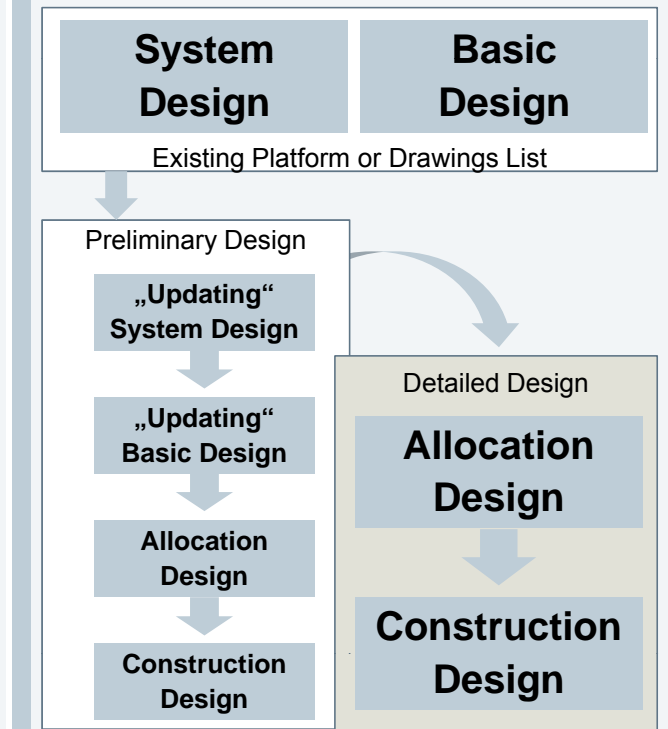
## Engineering Process of Catenary Lines



## Engineering Process of Catenary Lines during "Brownfield" projects

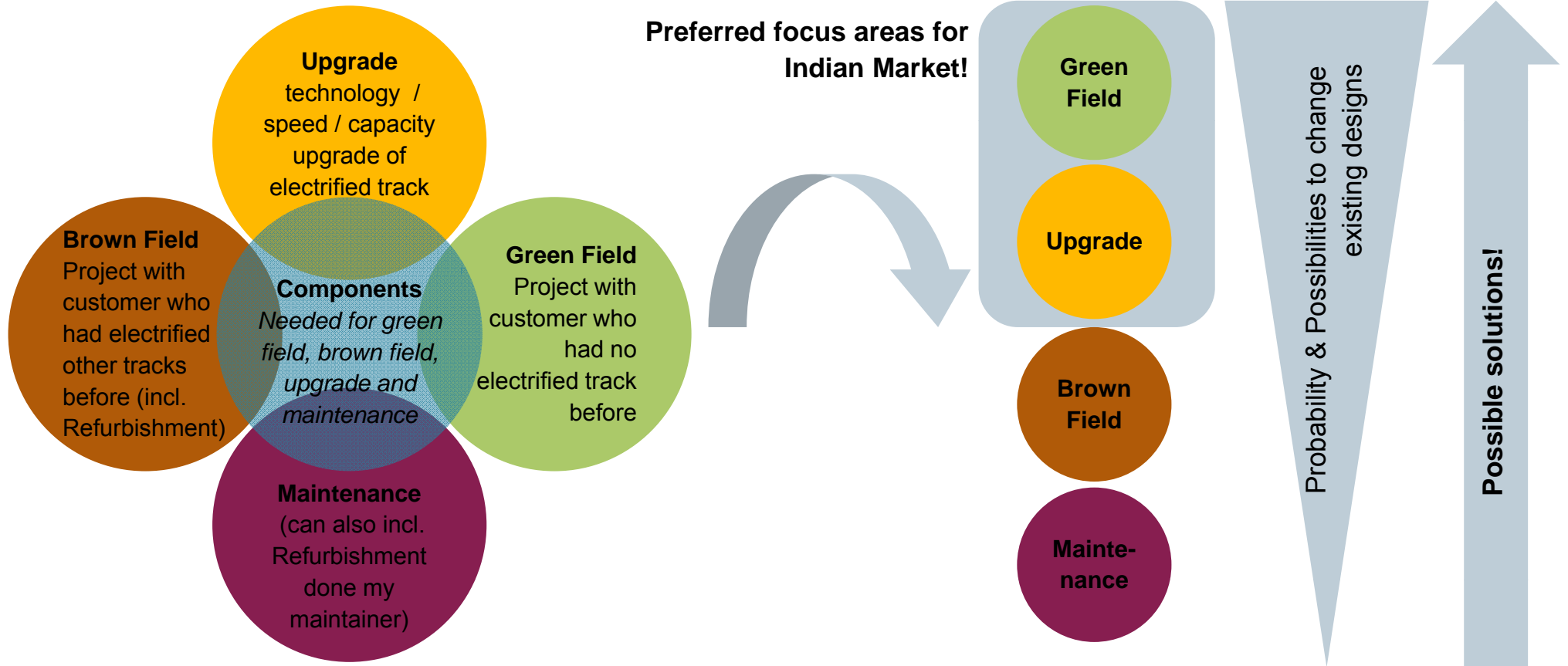


## Engineering Process of Catenary Lines for Greenfield projects



**The Sicat platform is our technical base to serve successfully project business.**

# Four type of projects, which requires different approaches. To innovate and improve needs to focus on right settings.



# Sicat SA

AC overhead contact line up to 230 km/h – our top seller

**SIEMENS**

*Ingenuity for life*



## Standard values (!)

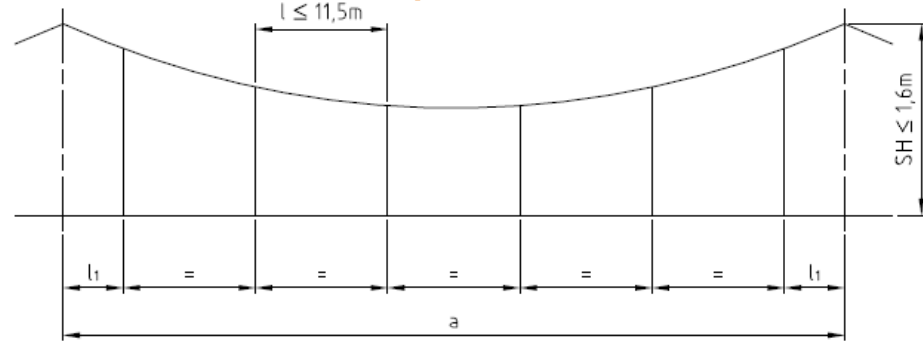
Rated voltage	15 kV AC/ 16.7 Hz 25 kV AC/ 50/60 Hz
Running speed	up to 230 km/h
System height	1.80 m
Contact wire to EN 50149	AC-100 to AC-107, Cu-ETP/CuAg0,1
Catenary wire to DIN 48201	50 to 70 mm <sup>2</sup> , BzII
Dropper / stich wire	10 mm <sup>2</sup> , bronze, high-flexibility / > 160 km/h with stich wire
Tensioning force, contact wire	10..12 kN
Tensioning force, catenary wire	10..12 kN
Span length	up to 80 m
Tension length	up to 1,800 m
Current carrying capacity	up to 700 A

# Sicat SA

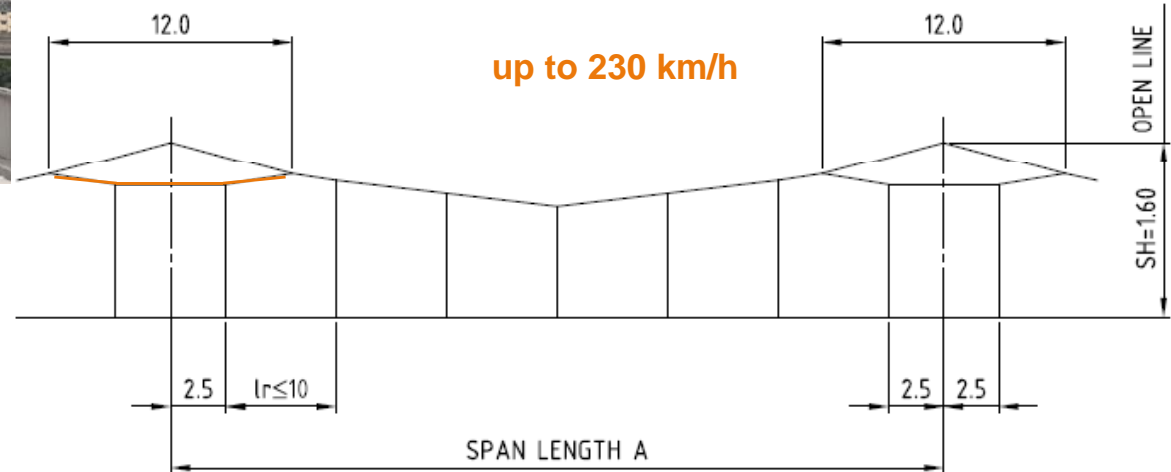
If adjusting operational speed would be always so easy



up to 160 km/h



up to 230 km/h



No change on component level, current carrying capacity & supports/poles!

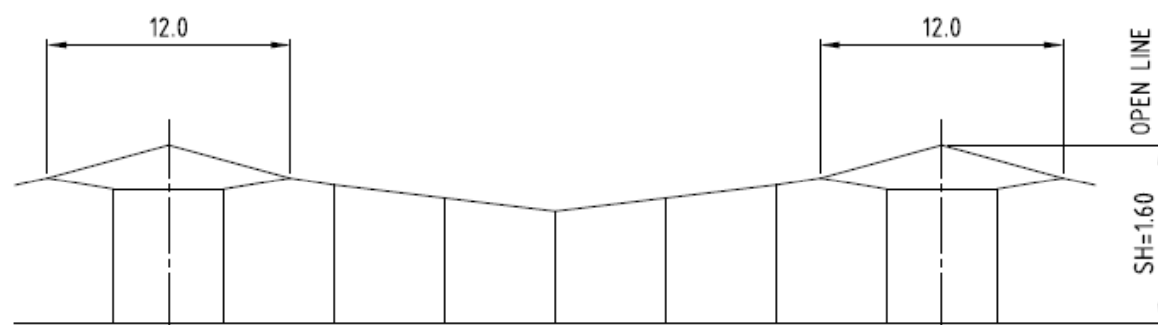
**Lever for speed upgrade: Stich wire!**

# Sicat SA

If adjusting current carrying capacity would be always so easy

**SIEMENS**

*Ingenuity for life*



	<b>Sicat S 1.0*</b>	<b>Sicat SA</b>
Catenary wire:	BzII 50 (10 kN)	BzII70 (12 kN)
Contact wire:	AC-100 CuAg0,1 (12 kN)	AC-107 Cu-ETP (12 kN)
Capacity**	≈550 A	≈ 650 A
Stich wire:	yes	yes

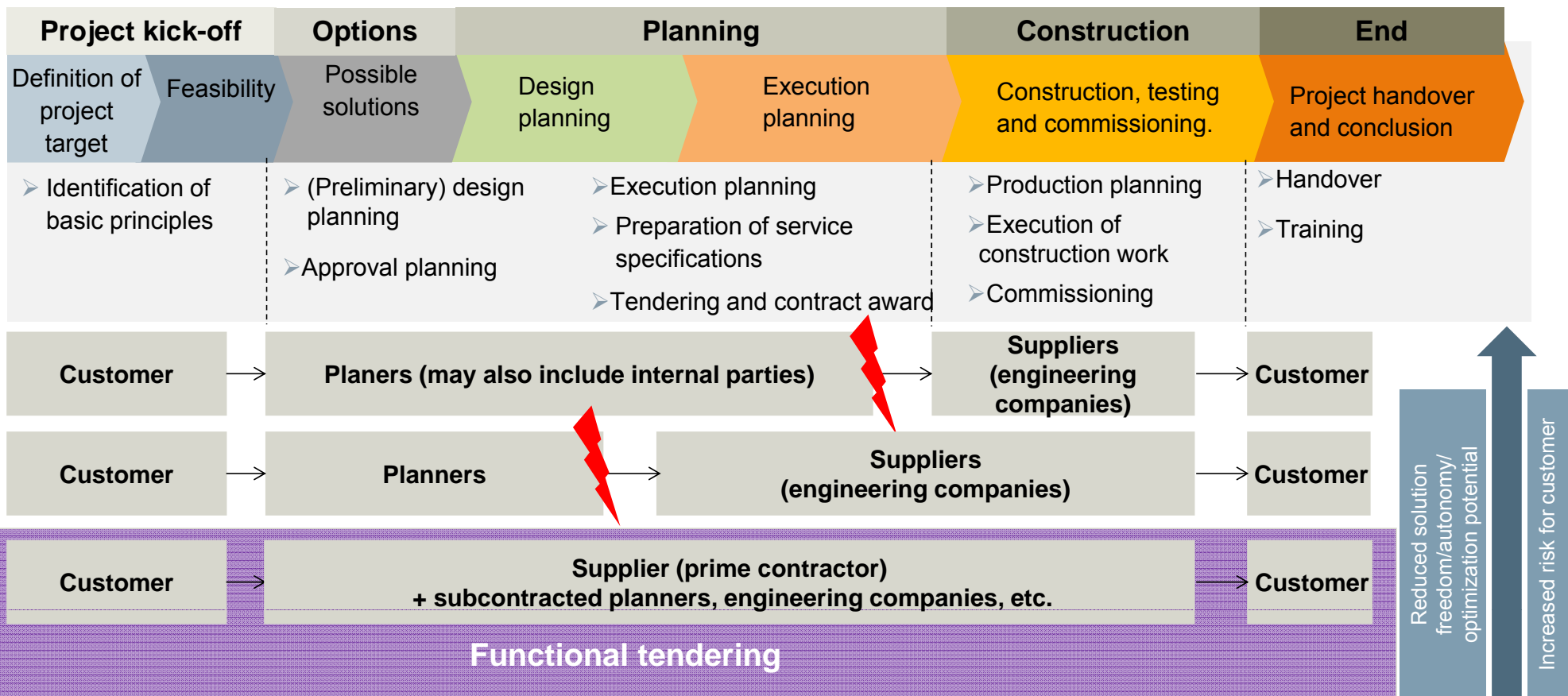
**Lever for current carrying capacity upgrade: system design on catenary wires!**

\*- CW for Re160/Re200 AC-100 Cu-ETP tensioned with 10 kN

\*\* - Depends on ambient conditions, etc.

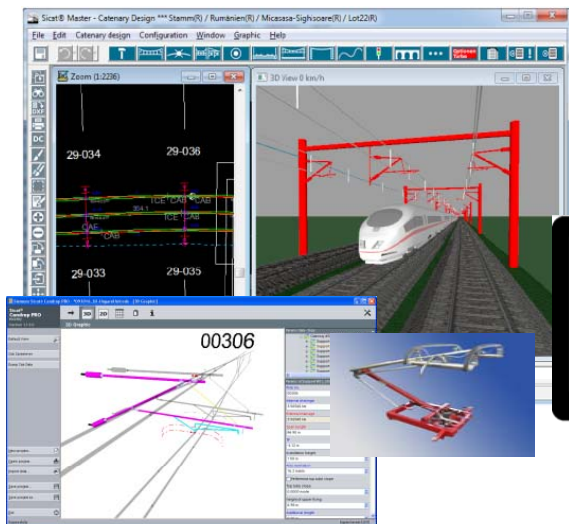
**How to support the best solution, without making full detailed specifications?**

# Comparison of organisational setups in different tenders

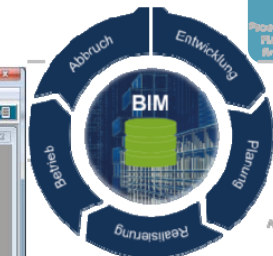


# Innovations in the field of contact lines – possible with less restricted specifications

Digitalization in planning, development and construction



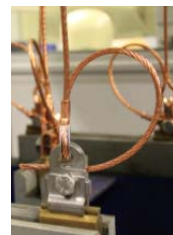
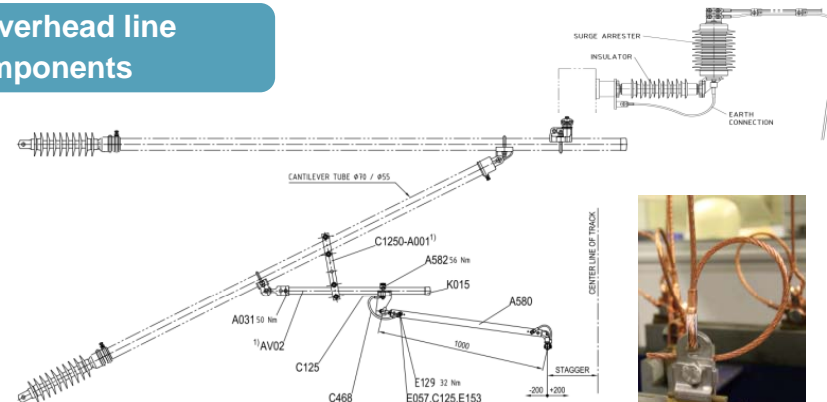
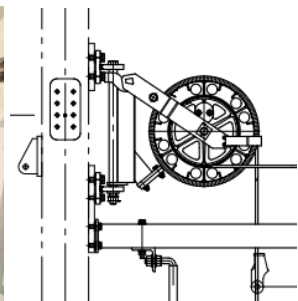
Digitalization in operation and maintenance



Recording, evaluation and validation of RAMS/LCC



New overhead line components



Assembly technology



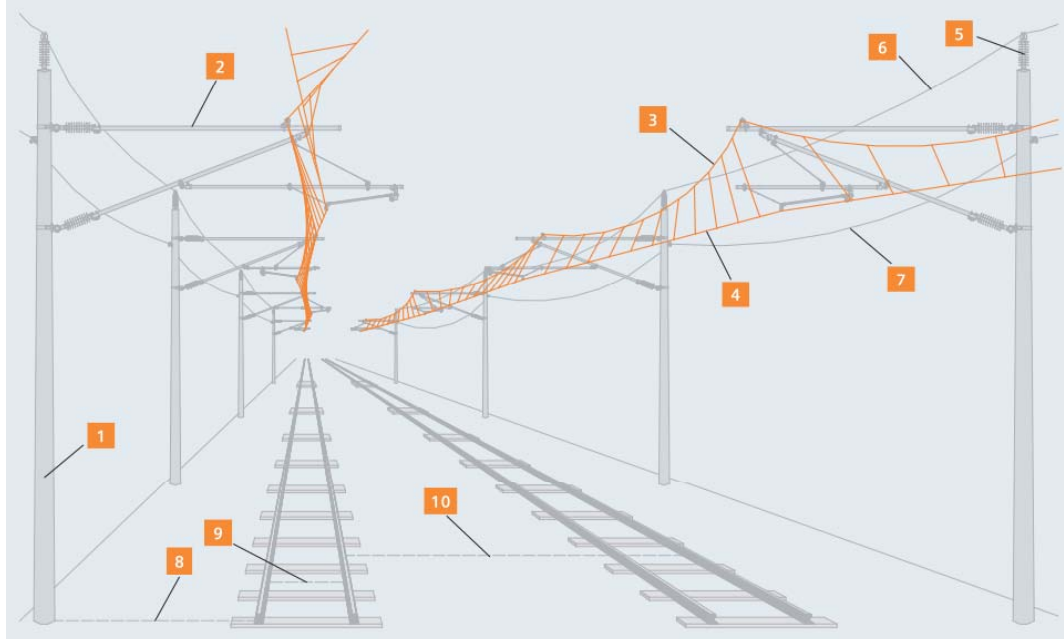
New models



# New OCL system Sicat SX

## Layout of a fully inclined overhead contact line

### Layout diagram



- |                 |                |                    |
|-----------------|----------------|--------------------|
| 1 Pole          | 4 Contact wire | 7 Return conductor |
| 2 Cantilever    | 5 Insulator    | 8 Pole grounding   |
| 3 Catenary wire | 6 Line feeder  | 9 Rail bond        |
| 10 Cross bond   |                |                    |

### Advantages

- Auto-tensioned catenary **without stitch wires** with up to **110 m span length**
- **Low weight** of the catenary system itself
- **Staggered suspension points** of catenary wire and contact wire
- **High degree of elasticity** in the contact line
- Excellent **dynamic interaction** between pantograph and contact line
- Use of **proven standard components**
- for AC 25 kV up to 250 km/h

A blurred high-speed train is shown in motion, passing through an overhead contact line (OCL) system. The train is white with a blue stripe. The OCL system consists of multiple overhead wires supported by a complex structure of metal poles and cross-arms. The background is a clear blue sky. The train is moving from left to right, creating a motion blur effect.

**What could we learn from operation, installation and maintenance of high speed lines to improve standard OCL?**

# Experiences from operation on high-speed OCS with Sicat H – it's more than proceeding speed record runs!

**SIEMENS**  
*Ingenuity for life*

- High speed OCS works on the limits of the system and it's elements (often two PANs!)
- A sufficient design for (high speed) OCS needs experiences and investigations for the complete system and the elements
- High-speed allows only a small bandwidth for tolerances!
- The pantograph must fulfill the requirements

⇒ Total system must be qualified for the (high-)speed requirements!

⇒ The better the design & installation, the better the performance and lower the LCC!



Cologne – Frankfurt (Germany)



HSL Zuid (Netherlands), 99.4 % availability requirements!



JJ-Line (China), 110 km double track @27 month



Different projects in Spain

# Structure for overhead contact lines

## Element classification for functional definition

### Wiring (Catenary, feeders, conductors)

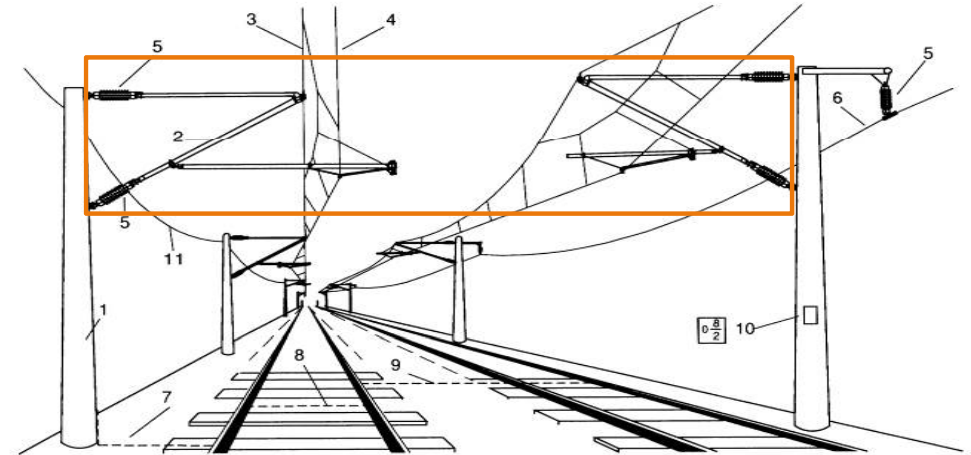
- Safe and secure operation
  - Wear of contact wire and collector strip
  - Current capacity (catenary and additional wires)
- ⇒ Important for the running speed and train operation

### Switching and insulation

- Sectioning
- ⇒ Electrical usability and equipment operation

### Structures

- Mechanical safety
  - Lifetime
  - Maintenance work
- ⇒ Integration in existing systems for outer functions arbitrary

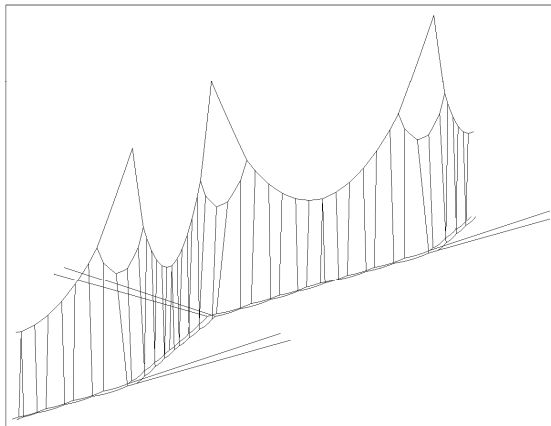


### Resume

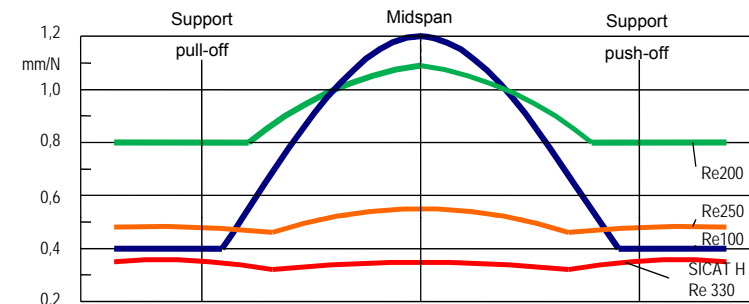
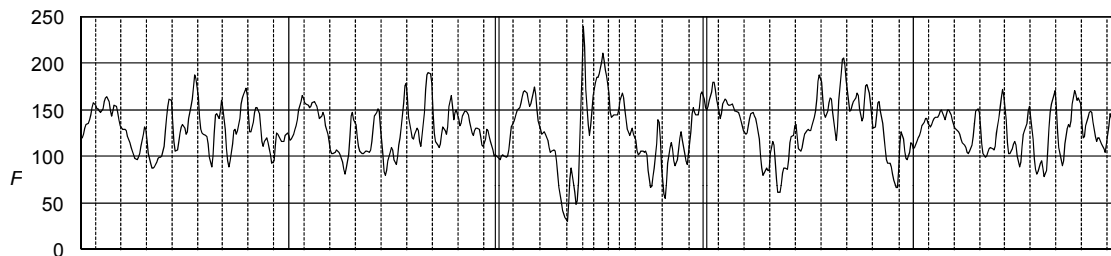
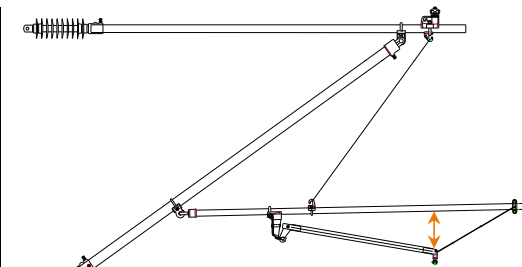
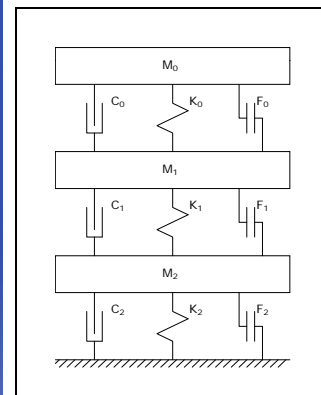
Greenfield or upgrade projects needs achievements for the catenary according interaction with pantograph and electrical capability. Flexible tenders easier LCC optimized solutions.

# Dynamic interaction evaluation by use of Sicat Dynamic to be done within system design!

Contact line

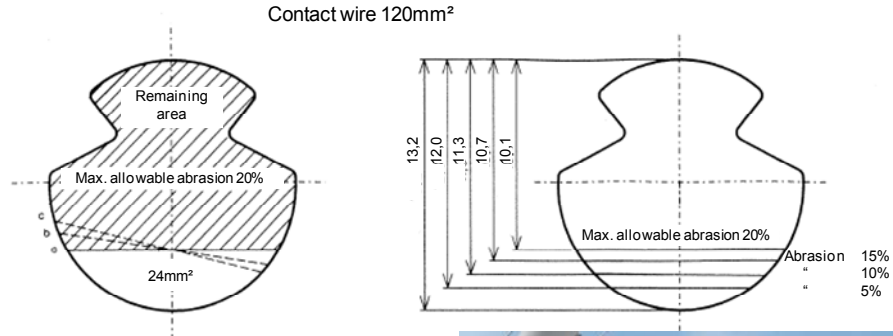


Pantograph



# Service life and contact wire wear on Germany's high speed OCL. This performance is also possible for standard speed range!

**SIEMENS**  
*Ingenuity for life*



- Catenaries live parts are designed as maintenance free with one exception: contact wire
- Service life expectations: 40 years (for accounting), 60..100 years (for maintainer 😊)
- Contact force measurement half a year
- Full “manual” Inspection of the OCL: ∅ 8..12 years
- Experience within Germany indicates at least **5.4 million pantograph passes** for High Speed lines



**How could we improve the installation process to go into mechanized installation?**

Installation always needs to be aligned acc. the requirements. No installation is similar to the other.

**SIEMENS**  
*Ingenuity for life*



Dependencies for Installation (examples):

- Service interruptions (e.g. on existing tracks)
- Other parallel installation processes
- Available installation technology / quantity / staff
- Logistic concept on raw material
- OCL design

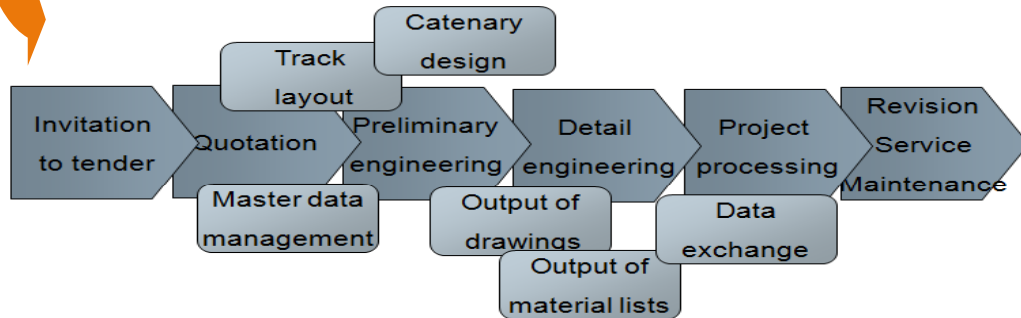
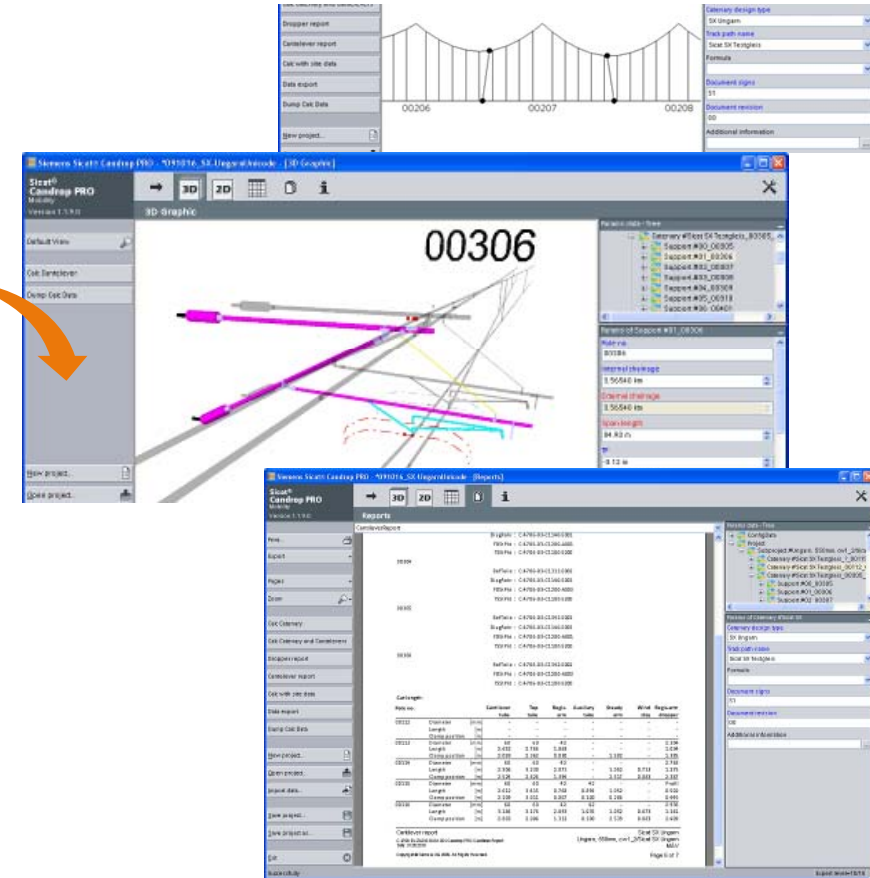
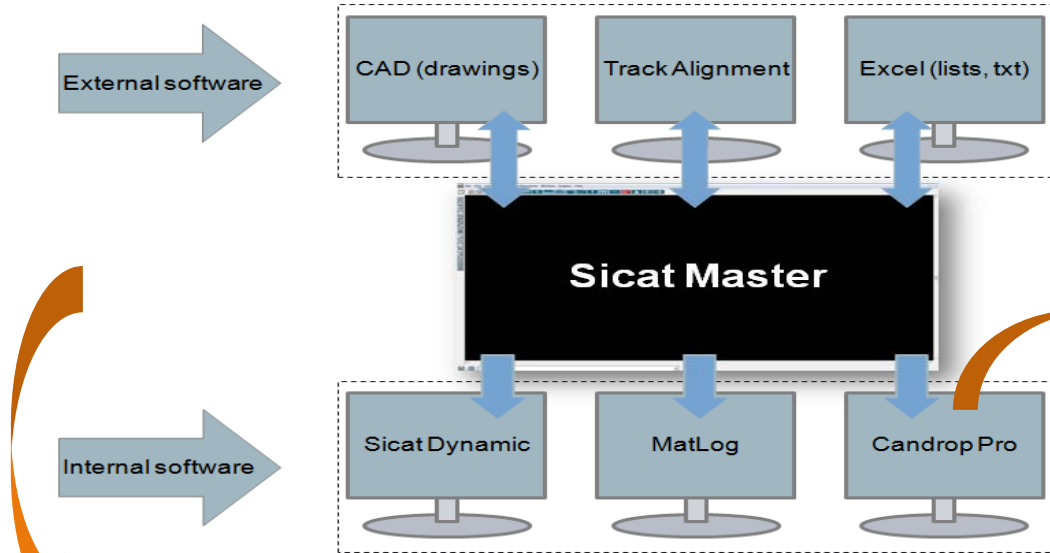
Goals for adjusting installation technology:

- Reduction of track access (quantities and duration)
- Acceleration of installation by optimized processes
- Offsite-Workshops for preassembling tasks
- Installation of preassembled devices
- Reduction of multiple final adjustments on OCL
- Limitation of installed components
- “Easy to understand” documentation (digital twin)

»Result of installation has to meet the requirements to operate trains at given speed and expected RAM/LCC-performance!

# Sicat Candrop & Sicat Master Using together to achieve optimum design & installation!

**SIEMENS**  
*Ingenuity for life*



# Example: Preassembling of low weight cantilevers with composite insulators

Delivery (1) or preassembly by installation company (2) – customer's choice



Preparing for transport, stacked, marked and sorted for easy installation



Transportation on site

# Example: Installation of low weight preassembled cantilevers with composite insulators



Prepare installation

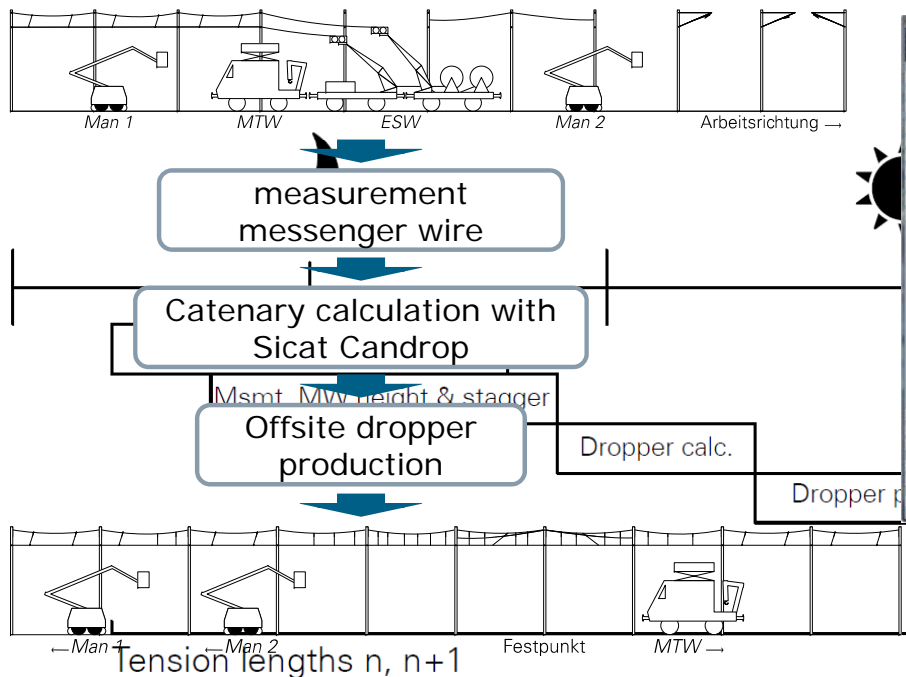


Installation



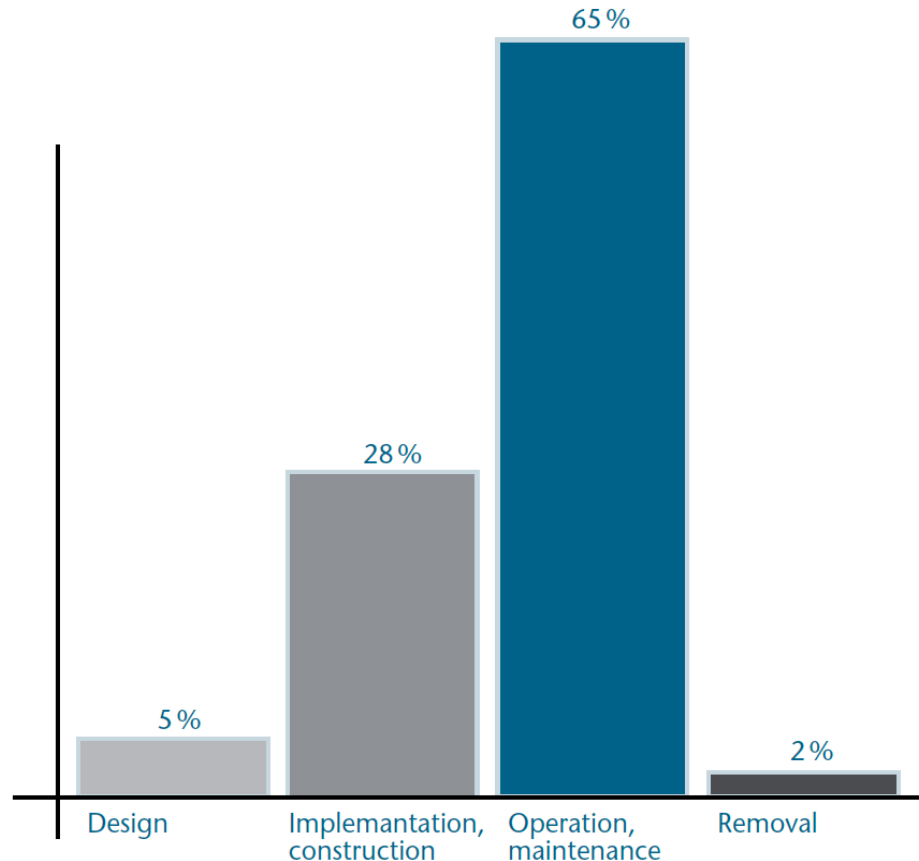
Installation without crane (approx. 35 kg/cantilever),  
only 2 workers *on platform* needed

# Example: Installation of the catenary wires incl. droppers for Denmark's EP project (first project, only night shifts)



**What should be considered to optimize costs and improve projects?**

# Typical LCC cost definitions for rail-bound systems and how to find the best solution!



- Significant cost driver are typically related to Operation & Maintenance!
- Intelligence in Design (Engineering) effects all other following periods!!!
- Wrong focus on technology and supplier could have significant effect on operational & maintenance cost combined with effects on RAM performance!
- Best solution has to be developed country-by-country, project-by-project based on experience, customer expectations and regulations, local conditions, partners etc. → cluster solutions
- For companies reputation it's better, if everything runs smoothly instead of being on the first page on the newspaper

»Everything, which is not installed, has not to be maintained! This also reduces the break even for Electrification projects!

**Reliable & approved Sicat components and systems, domain know-how in overall and specific engineering disciplines mixed with a portion of innovation, automation & digitalization will result in the best in class contact line solutions to meet IR goals!**

# Suitable not only to the Olympic games 2008 in China – “the golden OCL” from Siemens to have best tailored OCL solutions for India!

**SIEMENS**  
*Ingenuity for life*



If you think the way you have always thought,  
you will act as you have always acted.

If you act the way you always did,  
you will do what you have always done.

(Albert Einstein)

**SIEMENS**



**Together we can  
trendsetting!**

**Thank you for your attention!**

# Contacts



**Dr. André Dölling**

Senior Key Expert Contact Lines

MO TPE RE M&P

Mozartstraße 33b

D - 91052 Erlangen

Phone : +49 (151) 09026336

Email: [andre.doelling@siemens.com](mailto:andre.doelling@siemens.com)