



Introduction of Linde @ CO-LaN. Linde's Perspective on CAPE-OPEN.

Dr. Oliver Koch
Amsterdam, 14.10.2015

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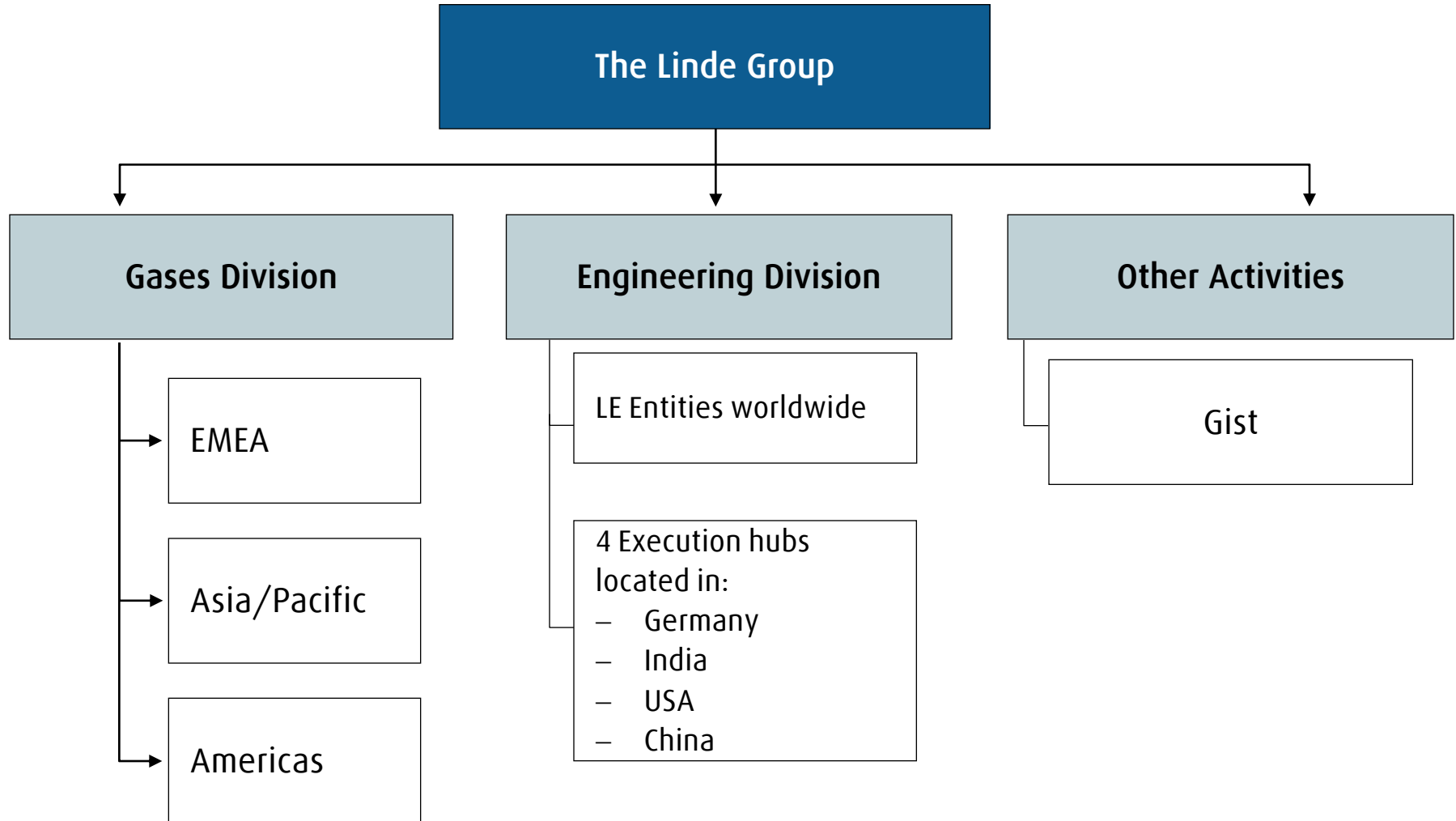
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- 1. Introduction to The Linde Group**
- 2. IT Infrastructure of Linde Engineering**
- 3. Our Experiences with CAPE-OPEN**
- 4. Our Needs with Respect to CAPE-OPEN**

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Group profile

Organisational structure



Linde Engineering with leading market position in all segments

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Air Separation Plants



Hydrogen and Synthesis Gas Plants



Petrochemical Plants



Natural Gas Plants



Providing plants for Linde Gas and
3rd party customers

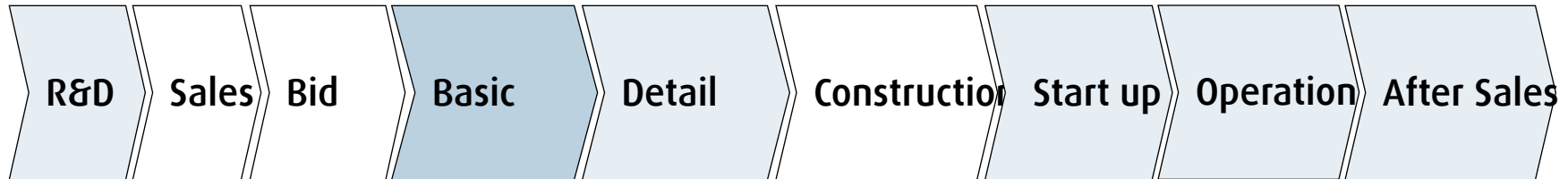
Providing plants for chemistry and energy
related industries

With around **1,000 process engineering patents/applications** and about **4,000 completed plant projects** Linde Engineering is supporting the energy/environmental mega-trend and leveraging customer relations for gas projects

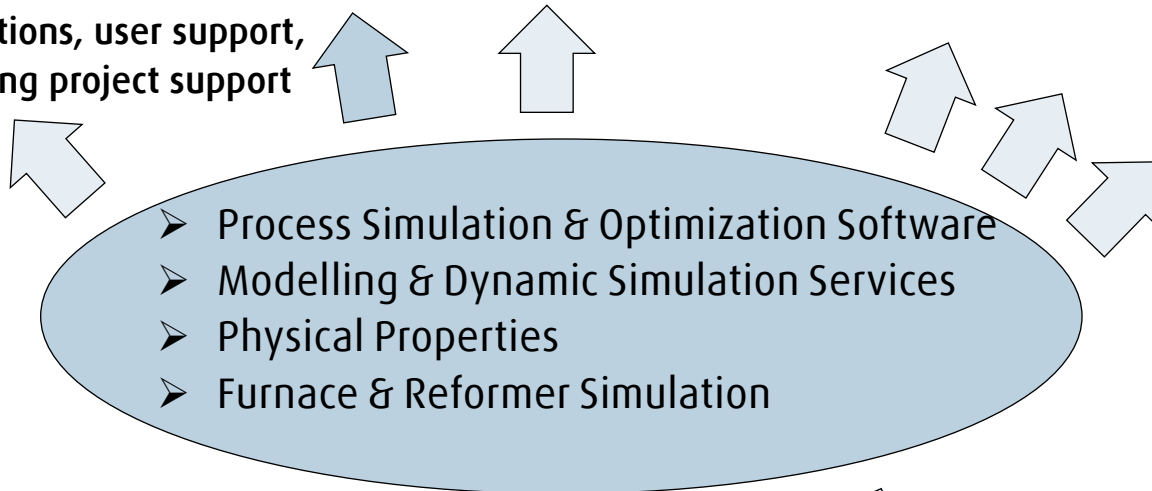
IT for Process Design and Control (LE-ITP) Overview

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IT applications, user support,
engineering project support



Linde Engineering

Linde Gas



Technology & Innovation



Group
R&D

Plant Operation
Performance & Production &
Supply Chain Optimization

- Chemists, Physicists, Chemical Engineers
- Responsible for Software Development and Maintenance of all kinds of Physical Properties
Software Tools used at Linde Engineering
- Main Software is GMPS as backbone of all Engineering Applications regarding Physical Properties
- Service to all kind of Physical Properties questions for Process Engineers at Linde

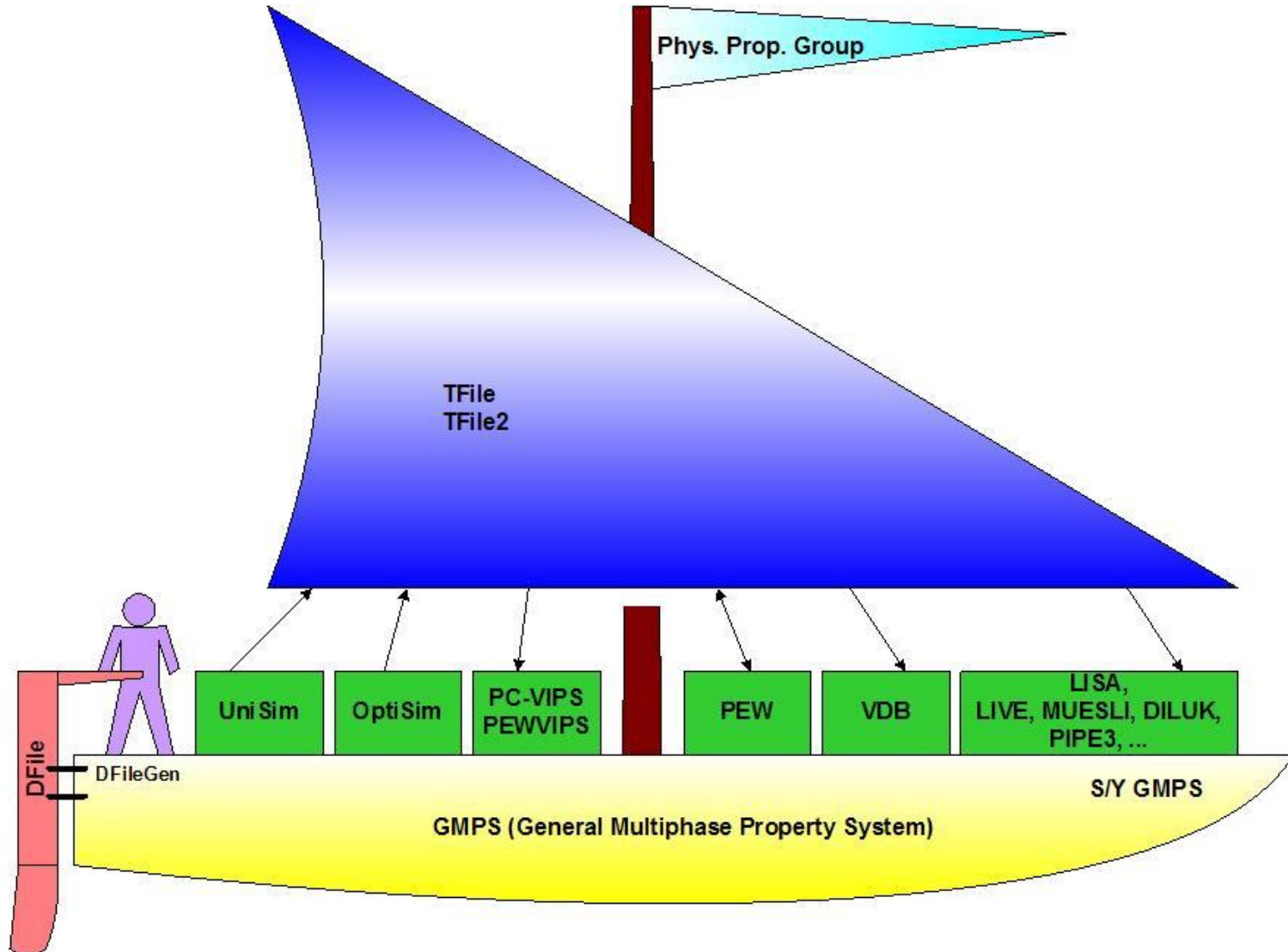
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Workflow at Linde Engineering



Physical Property System GMPS in a Nutshell

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- GMPS (General Multiphase Property System)
 - is Linde's proprietary in-house physical property prediction system
 - is the backbone of Linde Engineering's highly integrated workflow
 - is maintained by the Physical Property Group
 - contains 100 man-year of Physical Property expertise
 - can be applied to 1300+ Chemical Entities from 20+ Component Classes
 - can use 75 Physical Models (UNIFAC, SRK, PR, NRTL, CPA, Bender, IFC86, RefProp, TRAPP, ...)
 - predicts 45 Physical Properties (Flashes, Enthalpy, Density, Viscosity, Surface Tension, ...)
 - is able to predict Flashes with up to 9 Phases (Vap., Liq., Aqueous, Solids, Hydrates, Inerts)
 - predicts Physical Properties to 50+ Processes for all Product Lines
(Air Separation, Hydrogen & Synthesis, Petrochemical, Natural Gas, Adsorption)

- COM Interface (most used)
- Dynamic Link Library
- Static Link Library
- GMPS-UniSimThermo Interface to UniSim Design via COM Interface
- Material Object in GMPS (GMPS as PME)
- ICapeThermo in GMPS (GMPS as PMC, alpha Version)

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Experiences with CAPE-OPEN

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- Material Object in GMPS (GMPS as PME) since 2012
- ICapeThermo in GMPS (GMPS as PMC) since 2009
- Neither of them Used in Real Project so far
- Currently Intensive Validation Project

Status of Validation

PMC	PME	Simulator	Process	Result	Issues
RefProp	GMPS	UniSim	Dummy	Successful	2
AspenProperties	GMPS	UniSim	HS Plant	Successful	2
AspenProperties	GMPS	UniSim	Cracker	In Process	2
HYSYS	GMPS	HYSYS	Dummy	Stalled	1
GMPS	COFE	COFE	Dummy	Failed	5+
GMPS	AspenPlus	AspenPlus	tbd	Open	
GMPS	Pro/II	Pro/II	tbd	Open	?
Multiflash	GMPS	UniSim	tbd	Open	?

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Application of CAPE-OPEN @ Linde

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1. Include Third Party Processes in IT Infrastructure (GMPS as PME)
(e.g. AspenProperties as PMC)
2. Use GMPS in other Process Simulators or Engineering Applications (GMPS as PMC)
(e.g. Pro/II)
3. Include Third Party CAPE-OPEN Unit Operations into our Process Simulators
(e.g. Reactors in OPTISIM)

Needs of Linde with Respect to CAPE-OPEN

- Reliability:
Any Bug in an Engineering Project is a Risk for Schedule, Costs and Quality
- Prompt Bug-Fixes:
Bugs are Reality, but there is no Room for any Delay due to Unresolved Bugs in a Running Project
- Licenses:
When a Project comes up, Licences are needed quickly and with some Flexibility
- Persistence:
It is easier to use Packages with Persistence (No Need to provide CO Package, Registry Patches, Path Entries, ...)

Questions ???

Thermodynamics is a funny subject.
The first time you go through it, you don't understand it at all.
The second time you go through it, you think you understand it,
except for one or two small points.
The third time you go through it, you know you don't
understand it, but by that time you are so used to it, it doesn't
bother you any more.

Arnold Sommerfeld

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