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Securing TANGO Control System: A brain storming

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September 24th, 2013

Outline

1. Introduction
2. Identify scenarios
3. Cryptography engineering
4. Proposed solutions
5. Reference Papers
6. Journals & Conferences

What is an Industrial Control System? (ICS)

Wikipedia's definition (en)

"It is a general term that encompasses several types of control systems used in industrial production, including *supervisory control and data acquisition* (SCADA) systems, *distributed control systems* (DCS), and other smaller control system configurations such as *programmable logic controllers* (PLC) often found in the industrial sectors and critical infrastructures."

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What is a Programmable Logic Controllers

Figure: Part of a PLC controlled system

What is an SCADA?

Wikipedia's definition (es)

"*Supervisory Control And Data Acquisition* it is a computer software to control and supervise industrial process remotely."

Examples of an SCADAs

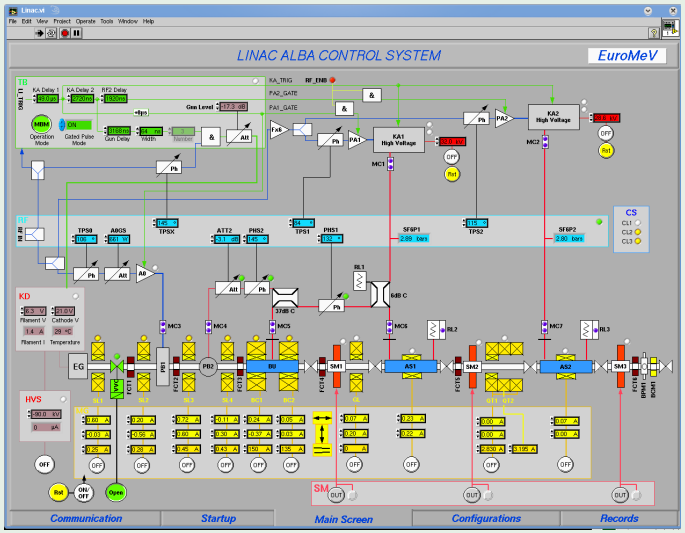


Figure: Labview as SCADA example

What is an Distributed Control System?

Wikipedia's definition (en)

a *Distributed Control System* is the computer software for a manufacturing system, process or any kind of dynamic system, in which the controller elements are not central in location (like the brain) but are distributed throughout the system with each component sub-system controlled by one or more controllers.

What is a distributed system?

Tanenbaum say [1]: *A distributed system is a collection of independent computers that appears to its users as a single coherent system.*

What is a TANGO? (I)

Tango is an object oriented *Distributed Control System* with active collaborative development from:

Figure: Logos of the Tango Consortium Members

What is a TANGO? (II)

It's an Distributed Control System

using CORBA as a Middleware (omniORB),
with ØMQ in the event broadcasting.

What means middleware?

Tanenbaum say [1]: *It is what supports heterogeneous computers and networks while offering a single system view.*

What is a TANGO? (iIII)

TANGO parts

- TANGO core ⇒ the Middleware
- TANGO Device Servers ⇒ the agents in the DCS

Device servers, device classes, and devices

TODO: "*Draw a nice picture about what those three things are...*"

What has an Agent (a device)

TODO: "*commands,attributes and properties*"

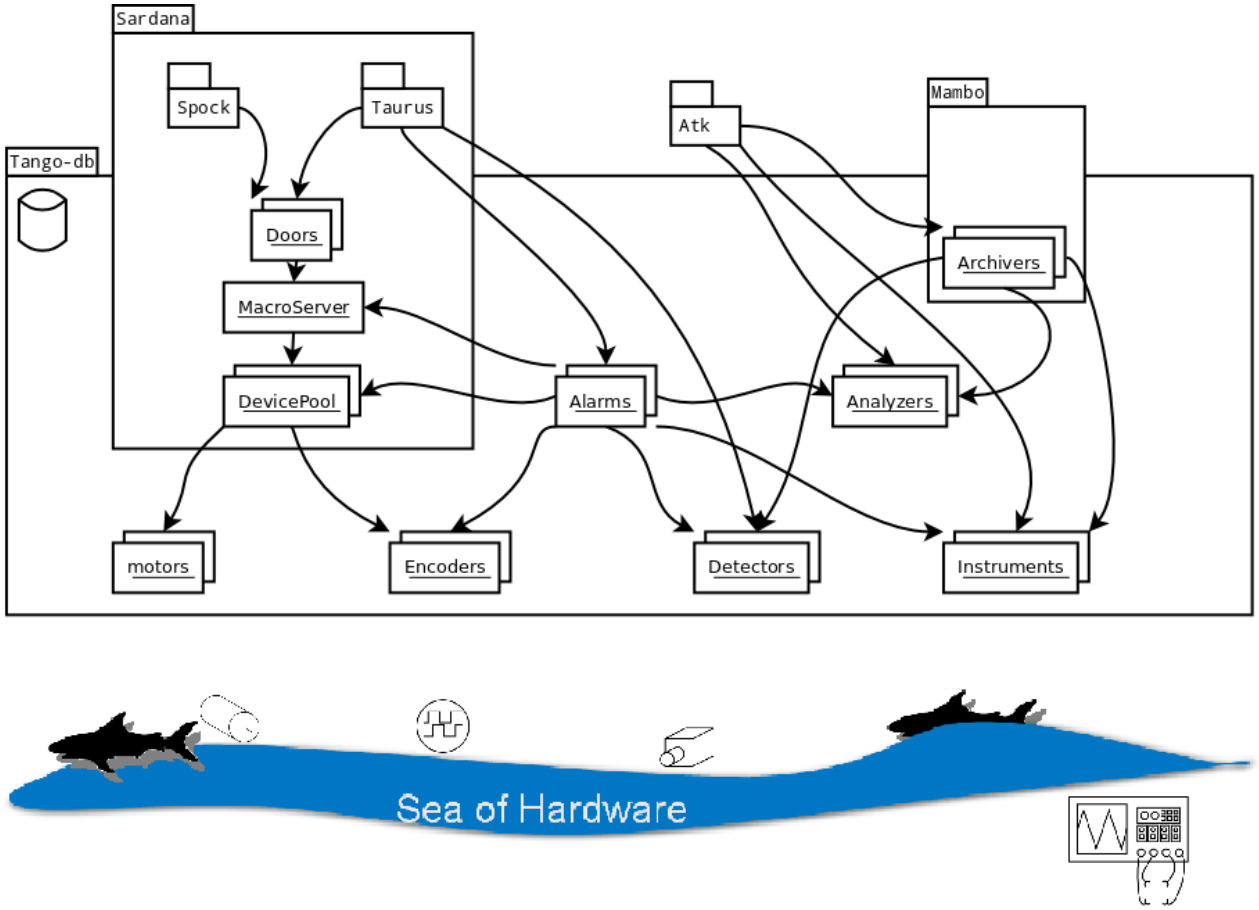
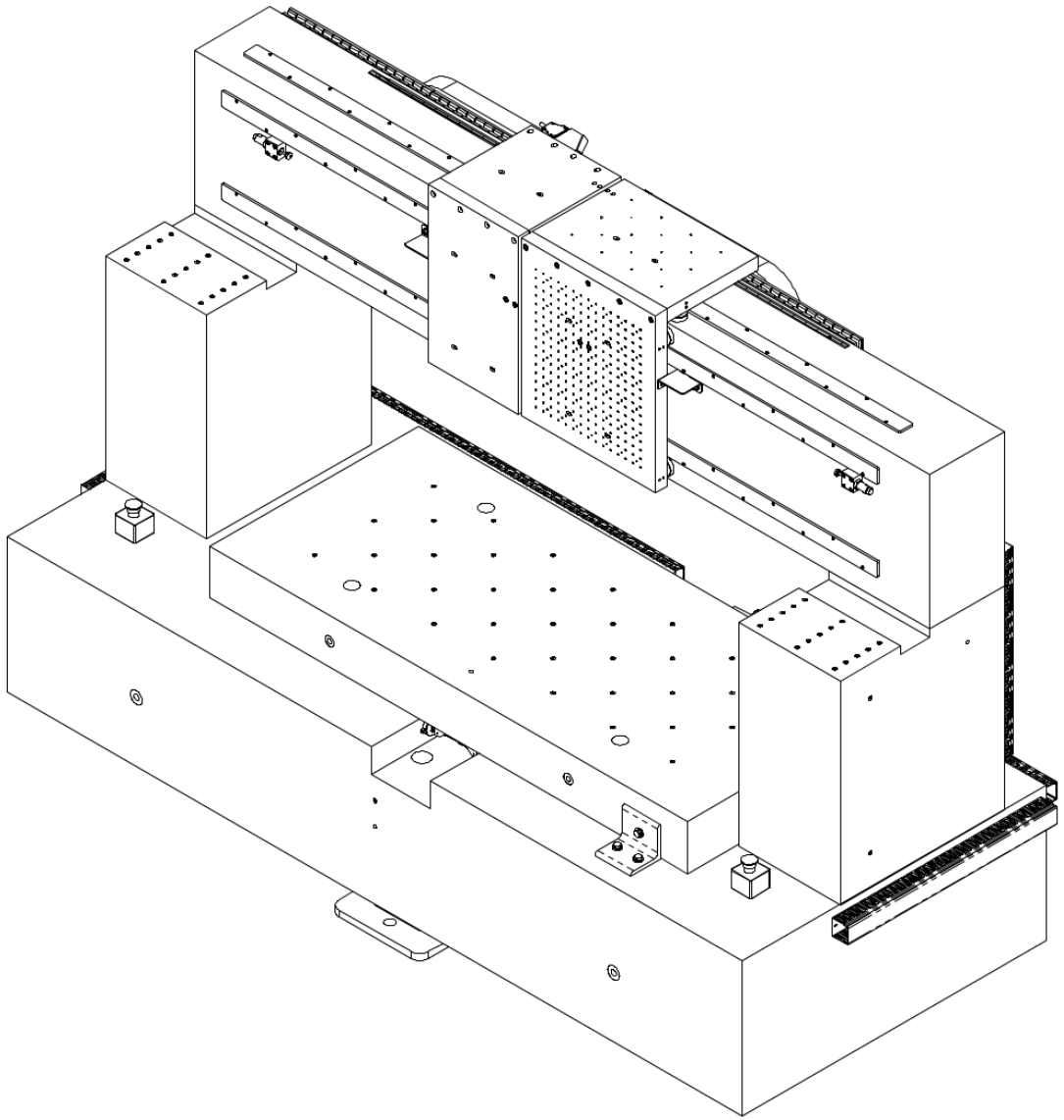
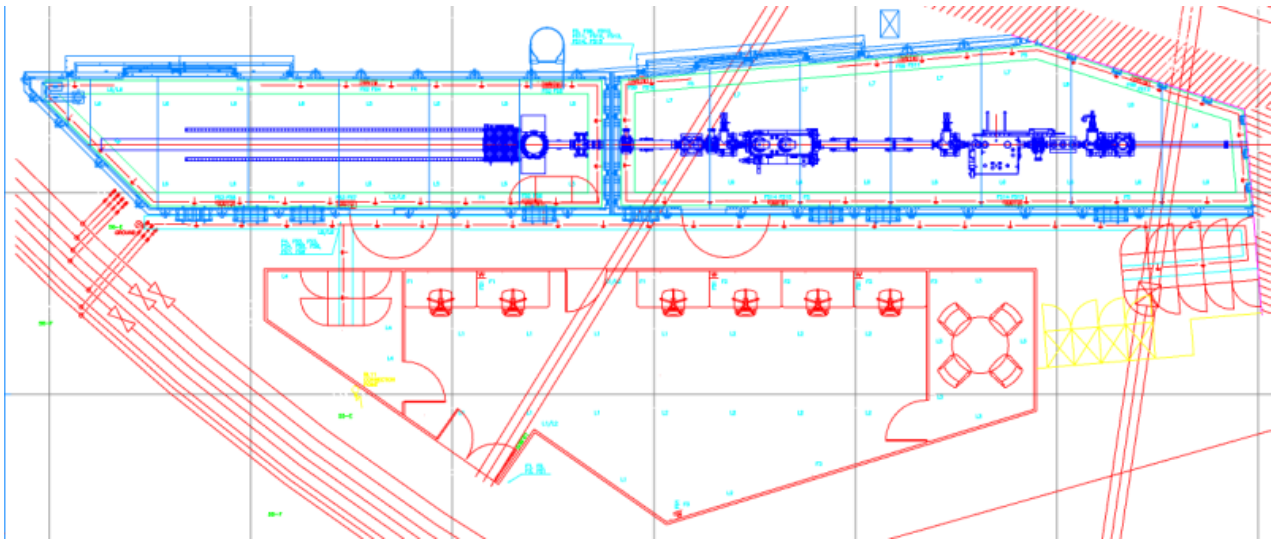


Figure: Tango schematic layout

Optics Lab: Long Term Profiler



A beamline



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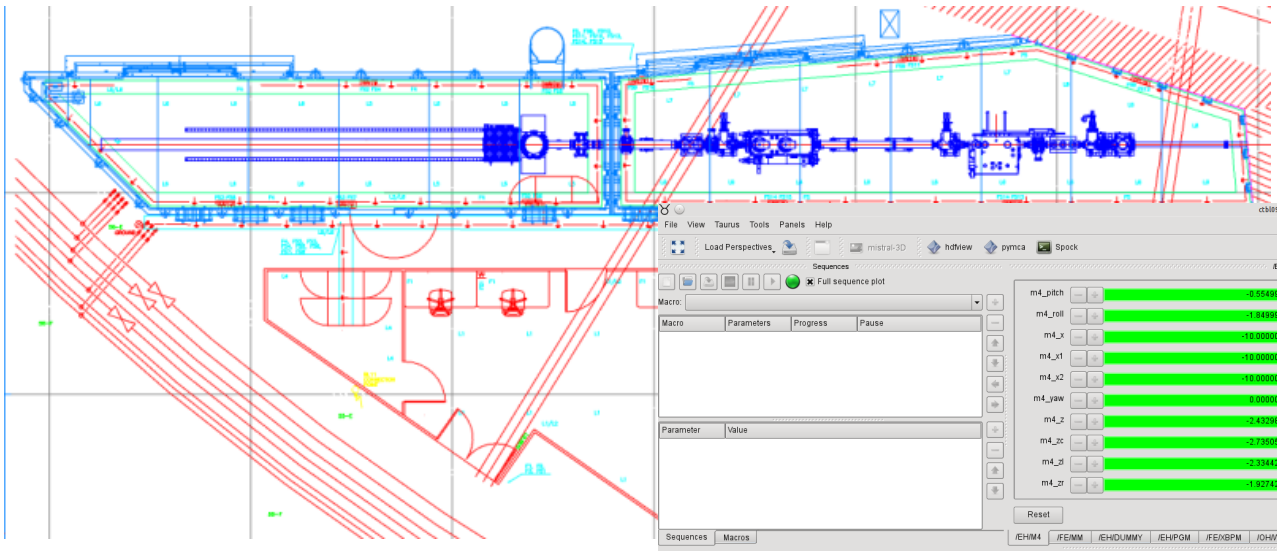

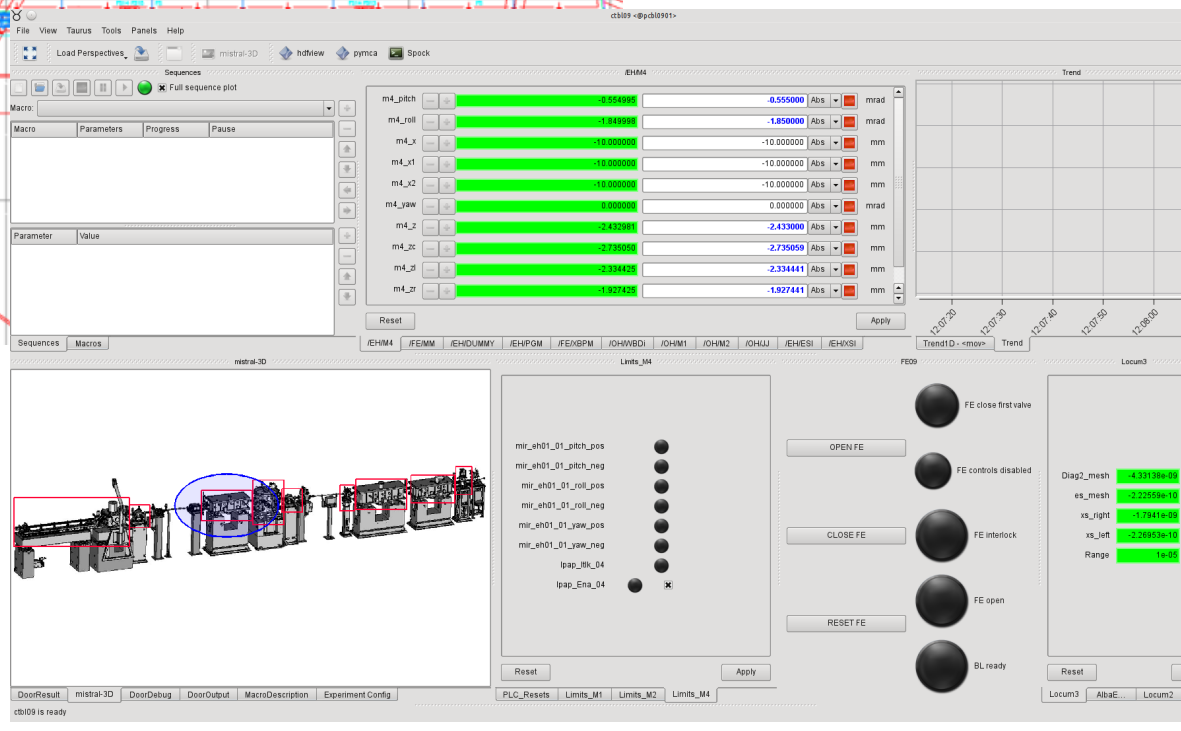
File View Taurus Tools Panels Help
Load Perspectives
Sequences
Full sequence plot
Macro
Parameters
Progress
Pause
Parameter
Value
Sequences
Macros
m4_pitch
m4_roll
m4_x
m4_x1
m4_x2
m4_yaw
m4_z
m4_zc
m4_zi
m4_zr
Reset
Apply
Trend
mistral-3D
Limits_M4
mir_eh01_01_pitch_pos
mir_eh01_01_pitch_neg
mir_eh01_01_roll_pos
mir_eh01_01_roll_neg
mir_eh01_01_yaw_pos
mir_eh01_01_yaw_neg
Ipap_ttlk_04
Ipap_Ena_04
OPEN FE
CLOSE FE
RESET FE
FE close first valve
FE controls disabled
FE interlock
FE open
BL ready
Locum3
DoorResult
DoorDebug
DoorOutput
MacroDescription
Experiment Config
PLC_Resets
Limits_M1
Limits_M2
Limits_M4
ctbl09 is ready

Control a synchrotron accelerator

- TODO: "*Draws of the synchrotron layout and data from the ccdb about the service area numbers*"
- TODO: "*List subsystems in the accelerator*"
  - Timming (132 agents)
  - Vaccum (1085 agents)
  - Power supplies (491 agents)
  - Radio frequency (124 agents)
  - Diagnostics (744 agents)
  - +2500 agents
- TODO: "*Astor*"

Against the transparencies

Access	Hide differences in data representation and how a resource is accessed
Location	Hide where a resource is located
Migration	Hide that a resource may move to another location
Relocation	Hide that a resource may be moved to another location while in use
Replication	Hide that a resource is replicated
Concurrency	Hide that a resource may be shared by several competitive users
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Security threads

All those transparencies shows at least on security issue

Basics on *information security*

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2. Integrity
3. Availability
4. Authenticity
5. Non-repudiation

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Those first 5 are the basics of the Information Security

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5. Non-repudiation
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6. Auditory
   - trace who access where
     (extremely useful for a security breach analysis).

Passive

- Eavesdropping

Active

- Men-in-the-middle
- Spoofing
- Noise-Interruption-poisoning: Block transmissions
  - Includes [D]DoS
- Modification/Fabrication: agent impersonate

counter-measures

- Intrusion detection and recovery

Security threads, policies and mechanisms

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Do not left all your security in ISO/IEC 27000-series!

Security levels

European commission *fiche 17*
"Exchange of EU classified information" [5]

- Open or Unclassified
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Sub-classifications

Elements in a group can have internal subsets. Agents with "Top-secret" access only under one subsystem, but "Confidential" under another.

Authentication

- Agent authentication
- User authentication (PAM in Unix)

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Rights

Who have rights to do any read/write action
Access Control Levels: would be similar than linux permissions
But multilevel and both directions.

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Tools

- Elliptic curve cryptosystem for TLS (RFC4492 [6])
- This one allow any curve (prime&char2) in WRF, unlike RFC6637 [7]

Encryption

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Tools

- Elliptic curves cryptosystem for *key exchange*
- (generalized) Rijndael and/or Stream cyphers for data transmission and event broadcasting

Database access

- TANGO-db is the "phone guide" of the system
  also stores persistent data, like the properties
- It is necessary to record over the properties:
  - Who and when modifies
  - Who and when reads (read should be also protectable)
- Should be possible to restrict areas of the "phone book"
  - It doesn't have much sense to say where an agent runs if you don't have right to talk with it
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Tools

- Homomorphic encryption/Ordered cryptography

5 Reference Papers

- Zero-knowledge proof
- Session key exchange
- Symmetric and stream cyphers
- Homomorphic encryption

(free) Paper sources

- International Association for Cryptologic Research (e-print & archiver)
- arxiv (open access e-print archiver)
- vixra (alternative open e-print archiver)
- citeseer (scientific search engine)
- scholar (Google's indexer)
- dblp (bib reference)

Zero-knowledge proof for authentication

- S.Martínez, "*Protocolos de seguridad para sistemas de identificación por radiofrecuencia*". PhD Thesis UdL, march 2011. Directed by: Concepció Roig and Magda Valls.[8]
- BSI TR-03110:"*Advanced security mechanisms for machine readable travel documents.*".[9]

key exchange

- R. Tomàs, "*Volcans d'isogenies de corbes el·líptiques: Aplicacions criptogràfiques en targetes intel·ligents*". PhD Thesis UdL, march 2011. Directed by: Josep M. Miret and Daniel Sadornil.[10]
- BSI TR-03111:"*Elliptic curve cryptography, version 2.0*" .[11]
- S. Blake-Wilson, N. Bolyard, V. Gupta, C. Hawk, and B. Moeller, "*Elliptic curve cryptography (ecc) cipher suites for transport layer security (tls)*" May 2006. RFC4492. [6]

Symmetric cyphers

- "*Specification for the advanced encryption standard (aes).*" Federal Information Processing Standards Publication 197, 2001.[12]
- J. Daemen and V. Rijmen, "*The Design of Rijndael*". Secaucus, NJ, USA: Springer-Verlag New York, Inc., 2002. [13]

- Smaller block size requested
- Bigger block size would be better than block cipher modes (CBC, CFB, CTR)

- J. Schaad and R. Housley, "*Advanced Encryption Standard (AES) Key Wrap Algorithm.*" Sept. 2002. RFC3394 [14]

Stream cyphers

- TODO: "*More information required!*"

Private database query system

- D. B. nad Craig Bentry, S. Halevi, F. Wang, and D. J. Wu, "*Private database queries using somewhat homomorphic encryption*," International Association for Cryptologic Research, June 2013.

Reference journals

- TODO: "*More information required!*"

Reference conferences & workshops

- Icalepcs: International Conference on Accelerator and Large Experimental Physics Control Systems
- No-bugs: New Opportunities for Better User Group Software
- CHES: Cryptographic Hardware and Embedded Systems
- SAC: Selected Areas in Cryptography
- Tango Meeting

References I


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Prentice Hall, 2002.
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R. J. Anderson, *Security engineering - a guide to building dependable distributed systems (2. ed.)*.
Wiley, 2008.


N. Ferguson, B. Schneier, and T. Kohno, *Cryptography Engineering: Design, principles and practical applications*.
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Updated by RFC 5246.


A. Jivsov, "Elliptic Curve Cryptography (ECC) in OpenPGP." RFC 6637 (Proposed Standard), June 2012.


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