≈ 600 km

≈ 200 km
Vehicles remain parked 95% of the time in a day...
ISO/IEC 15118
Road vehicles Vehicle-to-Grid Communication Interface
ISO/IEC 15118 Infrastructure

- User
- Mobility operator (MO)
- EP's Charging station (CS)
- Energy provider (EP)

Electric vehicle (EV)
EP's Charging station (CS)
Energy provider (EP)
ISO/IEC 15118 Infrastructure

User

Sign mobility contract

Mobility operator (MO)

Electric vehicle (EV)

EP's Charging station (CS)

Energy provider (EP)
ISO/IEC 15118 Charging Communication

User

Mobility operator (MO)

Electric vehicle (EV)

EP's Charging station (CS)

Energy provider (EP)
ISO/IEC 15118 Charging Communication

User

Mobility operator (MO)

Electric vehicle (EV)

Mobility Operator ID
Contract Cert.
Contract ID

EP's Charging station (CS)

Energy provider (EP)

The ISO 15118 protocol

The POPCORN protocol
ISO/IEC 15118 Charging Communication

User
Electric vehicle (EV)

Contract Cert.
Contract ID
Spot Operator ID
Power Outlet ID

Mobility operator (MO)

Energy provider (EP)

EP's Charging station (CS)
ISO/IEC 15118 Charging Communication

User

Mobility operator (MO)

Accept / refuse contract

Energy provider (EP)

Accept / refuse charging

Electric vehicle (EV)

EP's Charging station (CS)
ISO/IEC 15118 Charging Communication

User

Electric vehicle (EV)

Electricity

EP's Charging station (CS)

Energy provider (EP)

Mobility operator (MO)
ISO/IEC 15118 Charging Communication

User

Mobility operator (MO)

Dispute resolver (DR)

Energy provider (EP)

Electric vehicle (EV)

EP's Charging station (CS)

Electricity

Energy provider (EP)

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ISO/IEC 15118 Charging Communication

User

Mobility operator (MO)

User

Electric vehicle (EV)

Energy provider (EP)

Dispute resolver (DR)

Payment handler

Electricity provider (EP)

EP's Charging station (CS)

Signed meter readings

Electricity

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ISO/IEC 15118 Charging Communication

User

Mobility operator (MO)

Electric vehicle (EV)

EP's Charging station (CS)

Energy provider (EP)
ISO/IEC 15118 Charging Communication

User
Electric vehicle (EV)

Mobility operator (MO)
Dispute resolver (DR)
Energy provider (EP)

Signed meter readings
EP's Charging station (CS)
Energy provider (EP)

The ISO 15118 protocol
15118
The POPCORN protocol
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ISO/IEC 15118 Charging Communication

User

Mobility operator (MO)

Service detail record

Electric vehicle (EV)

EP's Charging station (CS)

Energy provider (EP)
ISO/IEC 15118 Charging Communication
ISO/IEC 15118 Charging Communication

User → Bill & inform → Mobility operator (MO)

Electric vehicle (EV) → EP's Charging station (CS) → Energy provider (EP)
Privacy concerns?
Privacy Impact Assessment
Direct EV identification
Direct EV identification

Charging location identification
Direct EV identification
Charging location identification
Enschede
MO identification and possibly home location

Direct EV identification
Charging location identification
Enschede
Direct EV identification

Charging location identification

MO identification
and possibly home location

EP identification
and possibly charging location

Enschede

UNIVERSITEIT TWENTE.

Ulm
ISO/IEC 15118

Charging Spot ID
Contract ID
Mobility Operator ID
Customer ID
Signed Meter Readings
Privacy Sensitive
Service Detail Record
Record Delivery
Contract Certificate
Signed Meter Readings
Privacy-Sensitive
Service Detail Record
Contract Certificate
Group
Signed
Meter
Readings

Privacy-
Preserving
SDR
Delivery

Anonymous
Contract
Credentials

Payment Links
Proof of Concept

Charging station

Charge indicators

Electric vehicle

Modified Ethernet cable
Conclusions
Conclusions

Can charging be privacy-preserving? ✓
Conclusions

Can charging be privacy-preserving? ✓
Is it feasible?

Based on ISO/IEC 15118
Preserving all protocol features
Possible to adopt parts only, but for less privacy

Our next step: Submitting the changes to ISO/IEC
Conclusions

Can charging be privacy-preserving? ✓
Is it feasible? ✓

- Based on ISO/IEC 15118
- Preserving all protocol features
- Possible to adopt parts only, but for less privacy
Conclusions

Can charging be privacy-preserving? ✓
Is it feasible? ✓

▶ Based on ISO/IEC 15118
▶ Preserving all protocol features
▶ Possible to adopt parts only, but for less privacy

Our next step: Submitting the changes to ISO/IEC
POPCORN
Privacy-Preserving Charging for eMobility

Christina Höfer
JBISA Presentation
9 October 2013
Extra slides
Group Signatures
Group Signatures

Dispute resolver (Group manager)

EV Alice
EV Bob
EV Charlie

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Group Signatures

Dispute resolver (Group manager)

Join group request

EV Alice

EV Bob

EV Charlie
Group Signatures

Dispute resolver (Group manager)

Membership

EV Alice

EV Bob

EV Charlie
Group Signatures

Dispute resolver (Group manager)

EV Alice
EV Bob
EV Charlie

abc
xyz
Group Signatures

Dispute resolver (Group manager)

EV Alice
EV Bob
EV Charlie

Verify signature

abc

xyz

Charging stations and Energy providers (Outsiders)
Group Signatures

Dispute resolver (Group manager)

EV Alice
EV Bob
EV Charlie

Charging stations and Energy providers (Outsiders)

Verify signature

abc
xyz
Group Signatures

Dispute resolver (Group manager)

EV Alice

EV Bob

EV Charlie

abc

xyz
Group Signatures

Dispute resolver
(Group manager)

EV Alice

EV Bob

EV Charlie

xyz
abc
abc
xyz

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Anonymous Credentials – Idemix
Anonymous Credentials – Idemix

Electric vehicle
(Prover)

Charging station
(Verifier)

Mobility operator
(Issuer)
Anonymous Credentials – Idemix

Electric vehicle (Prover)

Charging station (Verifier)

Mobility operator (Issuer)

Mobility Contract
EV-001-123
No Flatrate
2013-03-01
3042
Anonymous Credentials – Idemix

Create proof $\geq$ Mobility Contract EV-001-123 No Flatrate 2013-03-01 3042

Electric vehicle (Prover)

Charging station (Verifier)

Mobility operator (Issuer)
Anonymous Credentials – Idemix

Electric vehicle (Prover) → Send proof → Charging station (Verifier)

Mobility operator (Issuer)
Anonymous Credentials – Idemix

Electric vehicle (Prover)

Charging station (Verifier)

Mobility operator (Issuer)

Verify proof
Anonymous Credentials – Idemix

Electric vehicle (Prover) → Accept/Decline ← Charging station (Verifier)

Mobility operator (Issuer)