

# Monitoring Data Quality with Asset Analytics

David Rodriguez



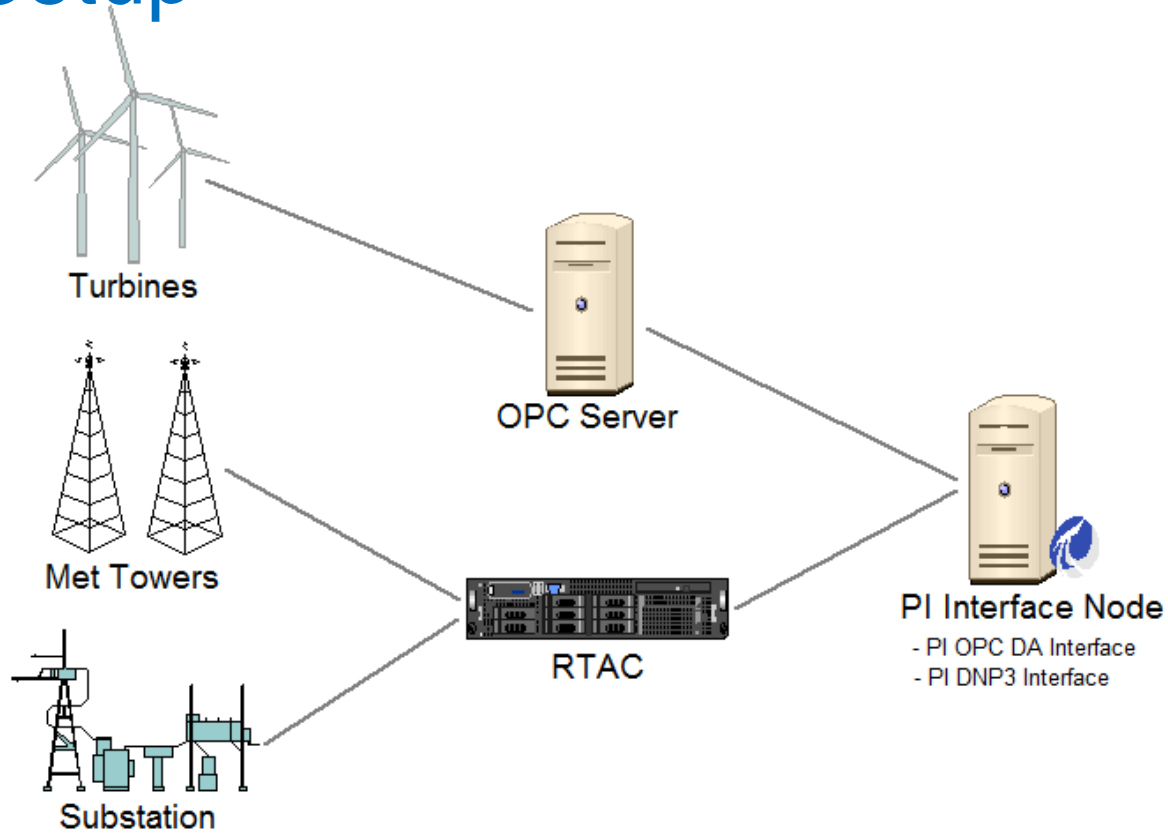
# What We're Covering

- Our Assets and PI System setup
- Data flow challenges
- Asset-level Monitoring
- Site-level monitoring and reporting
- Results and next steps

# Our Setup

- ~30 sites
- ~100 turbines per site on average
- PI node at each site with OPC and DNP3 interfaces
- Turbine data collected via OPC interface
- Substation and Met Tower via DNP3 interface
- PI nodes buffer to a central collective

# Our Setup



# Data Quality Challenges

- OPC server failures
  - Bad values such as “Comm Fail”, “I/O Timeout”
  - Stale data
  - Repeating value
  - Can affect all or only some turbines
- RTAC failures
- Met tower faults or sensor failures
- Network lag

# Our Needs

- Robust asset-level calculations to discern data interruptions
- Smart reporting that will bring issues to our attention without overwhelming
- Track performance to determine where to focus improvement efforts

# Common Approaches in Analytics

- **BadVal()**

Returns true if a given value or function is Bad

- **StDev()**

Takes the standard deviation of a given attribute over a specified time range

- **HasChanged()**

Returns true if a given attribute has updated over a specified time range

- **Event Count()**

Returns the number of events for an attribute over a specified time range

Elements

- Turbines
  - T01
  - T02
  - T03
  - T04
  - T05
  - T06
  - T07
  - T08
  - T09
  - T10
  - T11
  - T12
  - T13
  - T14
  - T15
  - T16
  - T17
  - T18
  - T19

T01

General Child Elements Attributes Ports Analyses

Filter

Name	Value
Category: Calculations	
Data Fault	0
Bad Check	0
PrevVal	13.1
Strike Count	0
Strike Max	3
Data Fault (2d)	0
Category: Measured	
Watchdog	3145.0

## Data Fault

- ~~Placed in the Strike Count~~ Highest value of Data Fault is 3. This detected bad data is not an issue
- ~~Can't set an issue~~ independently on module
- ~~Placed to archive this data~~

Name: Watchdog

Name: Data Fault

Name: Strike Max

Description: Highest tolerable strike count

Properties: Configuration Item

Categories:

Default UOM: <None>

Value Type: Int16

Value: 3

Data Reference: <None>

Display Digits: -5

Settings...



Add a new variable Evaluate

Name	Expression	V:	V:	Output Attribute
BadCheck	'Data Fault Bad Check'			Map
StaleCheck				Data Fault Strike Count
<pre>IF BadCheck THEN 'Data Fault Strike Max' ELSE (IF 'Watchdog'='Data Fault PrevVal' THEN 'Data Fault Strike Count'+1 ELSE 0)</pre>				
Update	IF BadCheck THEN NoOutput() ELSE 'Watchdog'			Data Fault PrevVal
FaultCheck	IF StaleCheck>='Data Fault Strike Max' THEN 1 ELSE 0			Map
FaultOutput	IF BadVal('Data Fault') OR Faultcheck<>'Data Fault' THEN Fault			Data Fault

Scheduling:  Event-Triggered  Periodic

Advanced...

Period: 00h 05m 00s, Offset: 00h 01m 30s

Configure

Add a new variable Evaluate

Name	Expression	Vz	Vz	Output Attribute
BadCheck	'Data Fault Bad Check'			Map
StaleCheck	IF BadCheck THEN 'Data Fault Strike Max' ELSE (IF 'Watchdog'='			Data Fault Strike Count
Update	IF BadCheck THEN NoOutput() ELSE 'Watchdog'			Data Fault PrevVal
FaultCheck	IF StaleCheck>='Data Fault Strike Max' THEN 1 ELSE 0			Map
<b>FaultOutput</b>				<b>Data Fault</b>

```

IF BadVal('Data Fault') THEN FaultCheck ELSE (IF Faultcheck<>'Data Fault' THEN
FaultCheck ELSE NoOutput())
  
```

Scheduling:  Event-Triggered  Periodic Advanced...

Period: 00h 05m 00s, Offset: 00h 01m 30s Configure

Add a new variable Evaluate

Name	Expression	Output Attribute
BadCheck	BadVal('Watchdog')	Map
TimeCheck	PrevEvent('Watchdog','*')	Map
StaleCheck		Data Fault Strike
<pre>IF BadCheck THEN 'Data Fault Strike Limit' ELSE (IF TimeCheck='Data Fault PrevEvent' THEN 'Data Fault Strike'+1 ELSE 0)</pre>		
Update	IF BadCheck THEN NoOutput() ELSE TimeCheck	Data Fault PrevEvent
FaultCheck	IF StaleCheck>=('Data Fault Strike Limit') THEN 1 ELSE 0	Map
Output	IF (BadVal('Data Fault') OR Faultcheck<>'Data Fault') THEN FaultCheck EL:	Data Fault

Scheduling:  Event-Triggered  Periodic Advanced...

Period: 00h 05m 00s, Offset: 00h 03m 00s Configure

Elements

- Turbines
  - T01
  - T02
  - T03
  - T04
  - T05
  - T06
  - T07
  - T08
  - T09
  - T10
  - T11
  - T12
  - T13
  - T14
  - T15
  - T16
  - T17
  - T18

T01

General Child Elements Attributes Ports Analyses N

Filter

Name	Value
Category: Calculations	
Data Fault	0
Data Fault (2d)	0
Data Fault (2d) (step 1)	0.28819
Category: Measured	
Watchdog	2044.0
Category: Performance	
Data Availability Pct (1w)	87.15 %

## Data Fault (2d) (Step1)

- ~~Displays the information~~  
 Data Fault (2d) (step 1) if the average Data Fault (2d) attribute over the past 95 days is greater than 95% of the past 2 days

Attribute: Data Fault

Data Reference: Formula

Display Digits: -5

Settings...

A = . |Data Fault (2d) (step 1); B = Data Fault; [if ((A > .95) and (B == 1)) then 1 else 0]

Calculation basis: time weighted

Min percent good: 80

Read only

Elements

- [-] Turbines
  - T01
  - T02
  - T03
  - T04
  - T05
  - T06
  - T07
  - T08
  - T09
  - T10
  - T11
  - T12
  - T13
  - T14
  - T15
  - T16
  - T17
  - T18
  - T19
  - T20
  - T21
  - T22
  - T23
  - T24

Turbines

General		Child Elements	Attributes	Ports	Analyses	No
<i>Filter</i>						
		Name		Value		
Category: Calculations						
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Asset Available Pct	98 %			
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Asset Fault Pct	2 %			
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Assets Available Count	92			
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Assets Faulted Count	1			
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Data Availability Pct (30d)	94.71 %			
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Data Fault	0			
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Data Fault (Step1)	0.010753			
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Minor Data Fault	0			
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Data-Hours Lost	0			
Category: Metadata						
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Asset Count	93			

Add a new variable



Evaluate

Name	Expression	Output Attribute
HoursLost		Minor Data Fault Data-Hours Lost

```
IF 'Assets Faulted Count' < 3 OR BadVal('Minor Data Fault|Data-Hours Lost') THEN 0 ELSE (IF 'Data Fault' THEN NoOutput() ELSE 'Minor Data Fault|Data-Hours Lost'+('Assets Faulted Count'*.25))
```

Scheduling:  Event-Triggered  Periodic

Advanced...

Period: 00h 15m 00s

Configure

Elements

- Turbines
  - T01
  - T02
  - T03
  - T04
  - T05
  - T06
  - T07
  - T08
  - T09
  - T10
  - T11
  - T12
  - T13
  - T14
  - T15
  - T16

Turbines

General Child Elements Attributes Ports Analyses Notification

Filter

Name	Value
Category: Calculations	
Asset Available Pct	98 %
Asset Fault Pct	2 %
Assets Available Count	92
Assets Faulted Count	1
Data Availability Pct (30d)	94.7 %
Data Availability Pct (30d) (Step1)	0.053024

## Data Availability Pct (30d) (Step1)

- Takes (Step1) weight attribute of the default Ratio over the past 30 days the result to reflect availability

Attribute: Data Fault | Data Fault (Step1)

Name: Data Availability Pct (30d)

Description:

Properties: <None>

Value Categories: Calculations

Default UOM: %

Value Type: Double

Value: 94.69 %

Data Reference: Formula

Display Digits: -5

Settings...

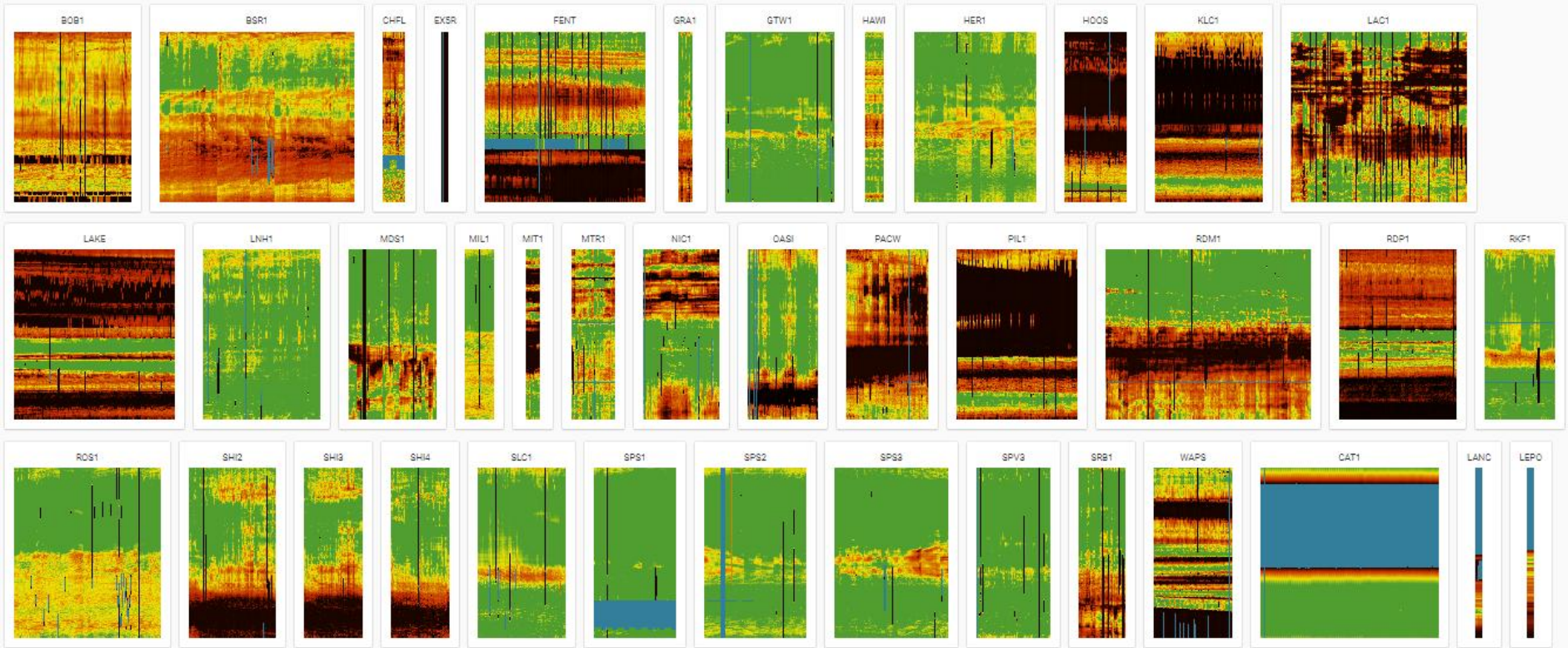
A = .[Data Availability Pct (30d) (Step1);  
[roundfrac((100\*(1-A)),2)]

# Results

- Turbine data issue response time reduced from hours to <30m
- Minor turbine issues addressed
- Substation and Met issues reduced from passive to <30m
- Data Quality improved from 90% to 97%



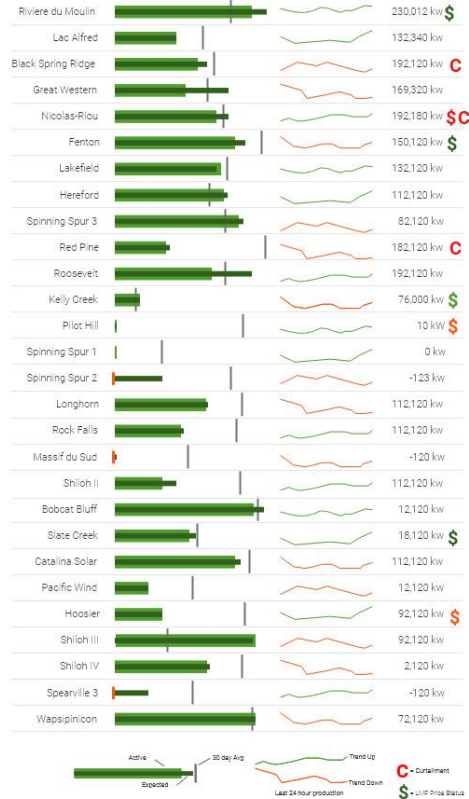
Visual Power



### Project Summary



### Active Power



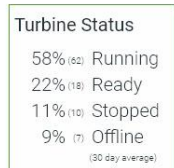
### Downtime Summary



### 30 Day Performance



### Asset Availability



<p>KLC1</p> <p>Excellent Infrastructure Status</p> <p>Excellent Data Quality</p>	<p>LAC1</p> <p>Excellent Infrastructure Status</p> <p>Excellent Data Quality</p>	<p>LAKE</p> <p>Excellent Infrastructure Status</p> <p>Excellent Data Quality</p>	<p>LANC</p> <p>Excellent Infrastructure Status</p>	<p>LEPO</p> <p>Excellent Infrastructure Status</p>
<p>LNH1</p> <p>Excellent Infrastructure Status</p> <p>Excellent Data Quality</p>	<p>MDS1</p> <p>Excellent Infrastructure Status</p> <p>Excellent Data Quality</p>	<p>MHY1</p> <p>Excellent Infrastructure Status</p>	<p>MIL1</p> <p>Excellent Infrastructure Status</p> <p>Excellent Data Quality</p>	<p>MIT1</p> <p>Excellent Data Quality</p>
<p>MR&amp;D</p> <p>Excellent Infrastructure Status</p>	<p>MTR1</p> <p>Good Infrastructure Status</p> <p>Fair Data Quality</p>	<p>NIC1</p> <p>Excellent Infrastructure Status</p> <p>Good Data Quality</p>	<p>OASI</p> <p>Excellent Infrastructure Status</p> <p>Good Data Quality</p>	<p>PACW</p> <p>Excellent Infrastructure Status</p> <p>Good Data Quality</p>
<p>PIL1</p> <p>Excellent Infrastructure Status</p> <p>Excellent Data Quality</p>	<p>PLY1</p> <p>Excellent Infrastructure Status</p>	<p>RDM1</p> <p>Excellent Infrastructure Status</p> <p>Excellent Data Quality</p>	<p>RDP1</p> <p>Excellent Infrastructure Status</p> <p>Excellent Data Quality</p>	<p>RKF1</p> <p>Good Infrastructure Status</p> <p>Excellent Data Quality</p>
<p>ROS1</p> <p>Excellent Infrastructure Status</p> <p>Good Data Quality</p>	<p>SHI2</p> <p>Excellent Infrastructure Status</p> <p>Excellent Data Quality</p>	<p>SHI3</p> <p>Excellent Infrastructure Status</p> <p>Excellent Data Quality</p>	<p>SHI4</p> <p>Excellent Infrastructure Status</p> <p>Excellent Data Quality</p>	<p>SLC1</p> <p>Excellent Infrastructure Status</p> <p>Excellent Data Quality</p>
<p>SPS1</p> <p>Excellent Infrastructure Status</p> <p>Excellent Data Quality</p>	<p>SPS2</p> <p>Excellent Infrastructure Status</p> <p>Good Data Quality</p>	<p>SPS3</p> <p>Excellent Infrastructure Status</p> <p>Excellent Data Quality</p>	<p>SPV3</p> <p>Poor Infrastructure Status</p> <p>Excellent Data Quality</p>	<p>SRB1</p> <p>Excellent Infrastructure Status</p> <p>Excellent Data Quality</p>

# Data Quality SPP

Updated 5:05:33 PM

## Turbine Data Quality

Availability 92/93

98.9 %

Data Availability (1w)

98.0 %

Data Availability

43 ms

Ping

100.0 %

Ping Uptime (1w)

OK

Ping Fault

OPCInt1

LOC.GTW1.OPC.GEW1A

Fault

Device Fault

2

Device Fault Count (1w)

OK

Heartbeat Fault

100.0 %

Heartbeat Uptime (1w)

I/O Rate

94

Device Avg Fault Time

3.5 days

Point Count

2,949

Tag Point Source

LOC.GTW1.OPC.GEW1A

# Next Steps

- Runaway lag trigger
- Data Substitution (where possible)
- Perfmon for OPC servers/RTAC
- Automated solutions, trigger scripts

# Thanks for Listening!



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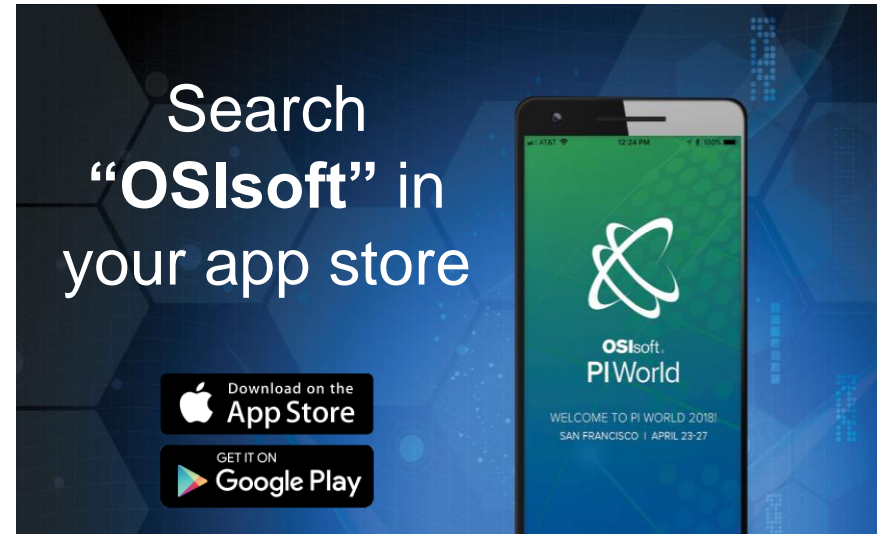
# Questions?

Please wait for  
the **microphone**



State your  
**name & company**

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 TAPADH LEIBH 고맙습니다  
 БАЯРЛАЛАА MISAOTRA ANAO  
 DZIĘKUJĘ CI NGIYABONGA TEŞEKKÜR EDERIM GRACIES OBRIGADO شكرا SALAMAT  
 KÖSZÖNÖM DANKIE TERIMA KASIH DANKON TANK TAPADH LEAT  
 СПАСИБО МУЛТUMESC  
 PAKMET CIZGE GO RAIBH MAITH AGAT OSIssoft. HVALA FAAFETAI  
 БЛАГОДАРЯ GRACIAS MAHADSANID HVALA ESKERRIK ASKO  
 TI БЛАГОДАРАМ HVALA ХВАЛА ВАМ  
 TAK DANKE MAHANSANID TEŞEKKÜR EDERIM  
 RAHMAT MERCI DANK JE EΥΧΑΡΙΣΤΩ GRATIAS TIBI GRAZIE  
 HATUR NUHUN AČIŮ SALAMAT MAHALO IĀ 'ŌE TAKK SKALDU HA DI OU MÈSI  
 GRAZZI ПAKKA PĒR ありがとうございます ǃAKUJEM  
 PAXMAT CAĜA SIPAS JI WERE TERIMA KASIH MATUR NUWUN  
 CẢM ƠN BẠN UA TSAUG RAU KOJ  
 WAZVIITA TI БЛАГОДАРАМ  
 СИПОС  
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THANK YOU